Technology Review

Edited at the Massachusetts Institute of Technology May 1961

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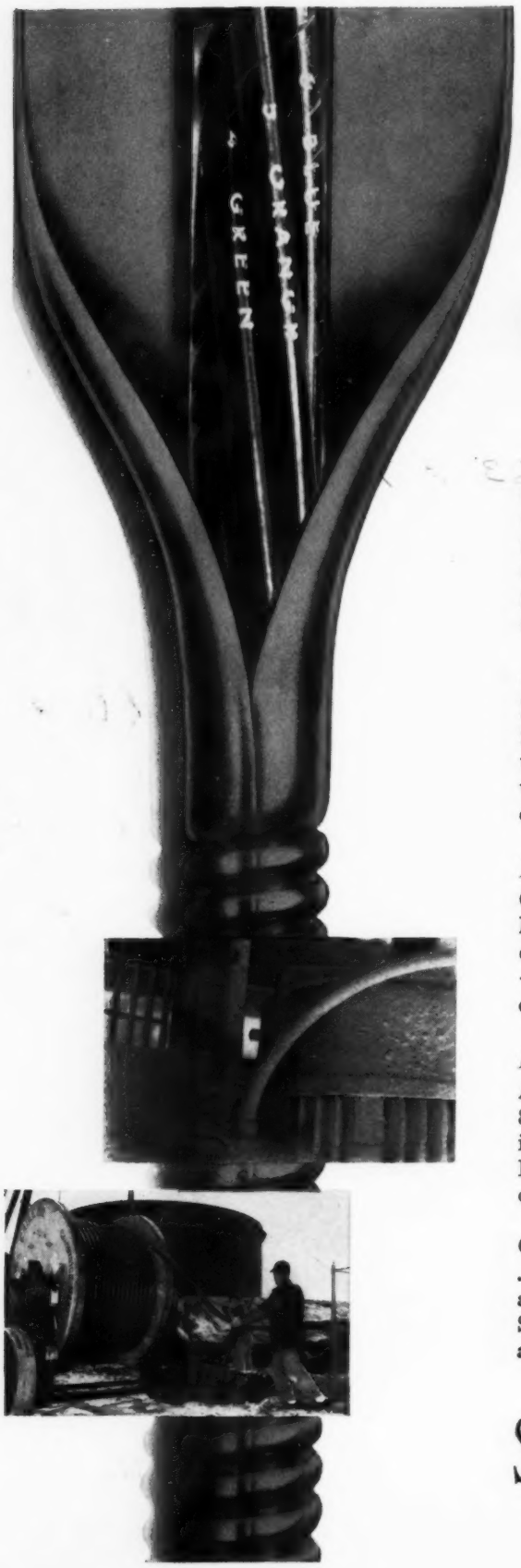
Men and Computers of the Future Page 17



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Simplex C-L-X is a packaged combination of cable an an extremely pliable, corrugated metal sheath. I requires no separate duct or conduit regardless o environment. It is available with steel sheath an plastic jacketing; and with copper or aluminu sheaths, with or without plastic jacketing.

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An East Coast petroleum tank farm used a C-L 8-conductor cable protected with PVC for direct buri in ground that was saturated with oil, gas and wate Result: Perfect performance at a sizeable saving over conduit systems.

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CAMBRIDGE, MASSACHUSETTS

All on a beam of light!

New Bell Telephone discoveries suggest light as a future carrier of vast numbers of telephone calls, TV shows, data messages!

Bell Telephone scientists recently transmitted the human voice for the first time on a beam of "coherent" infrared light.

To do this they used their new Optical Maser—a revolutionary device which may someday make light a new medium for telephone, TV and data communications.

Here's why:

Light waves vibrate tens of millions of times faster than ordinary radio waves. Because of these high frequencies, light beams have exciting possibilities for handling enormous amounts of information.

Ordinary light waves—the kind put out by your living room lamp—move like an unruly mob. Coherent light waves move like disciplined soldiers. Theoretically they can be controlled, directed and modulated just as radio waves are now.

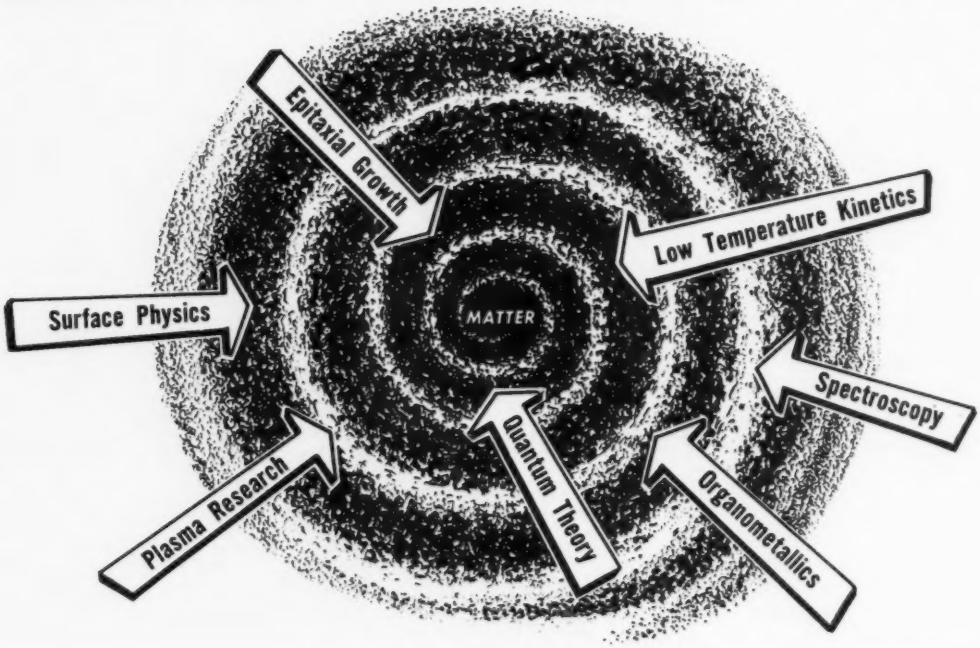
The possibilities are breath-taking. Light beams might be transmitted through long pipes, or could someday be just what are needed for communications in space—for example, between space ships.

Many other uses for coherent light beams are being thought of as Bell Laboratories experiments go forward. Continuing research like this requires adequate telephone company profits so that we can bring you the latest service improvements at the earliest possible time and the lowest possible cost.

Bell Laboratories scientist adjusts new Optical Maser model, first such that operates continuously. Maser uses very little power, transmits narrowest light beam ever achieved. Name stands for "Microwave Amplification by Stimulated Emission of Radiation."

BELL TELEPHONE SYSTEM

THE BREADTH AND DEPTH OF MELPAR: PROJECT PROBE



Project Probe consists of the division of research activity that slices horizontally through the areas of pure and applied physical, biological and engineering sciences. The basic philosophy of the program rests on the premise that only by such cross-disciplinary investigations and by a deep penetration into the fundamentals of science will true advances in electronics be forthcoming.

Melpar Project Probe is not restricted to a fixed family of products, but aims at expansion of knowledge and improvement of capability.

Melpar is seeking scientists and engineers with creative ability and scientific curiosity to participate in any one of the areas of this Probe.

INDICATIVE OF THE AREAS OF ACTIVITY PRESENTLY BEING PURSUED IN PROJECT PROBE ARE:

Bionics	Heterogeneous Reactions
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Basic Ceramics	Millimeter Wave Research
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Cryogenics	Acoustics
Communication Research	Stellar Phenomenon
Data Processing Research	NMR
High Temperature Measurements	Solid State Physics
High Pressure Physics	Magnetohydrodynamics
Logic Connectives	Adaptive Programming
Mathematical Circuit Synthesis	Microbiology
Mathematics	Microwave Optics
Pattern Recognition	Enzymology
Physical Chemistry	Upper Atmosphere Physics
Organic Chemistry	Optics
Semiconductor Physics	Oceanography
Radiochemistry	Electromagnetics
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Lasers	Biochemistry
Speech Compression	Biophysics
Infra-Red Research	Biology

Scientists and engineers who are interested in participating in MELPAR: PROJECT PROBE, are invited to write to F. J. Drummond, 3339 Arlington Boulevard, Falls Church, Virginia.

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Technology Review

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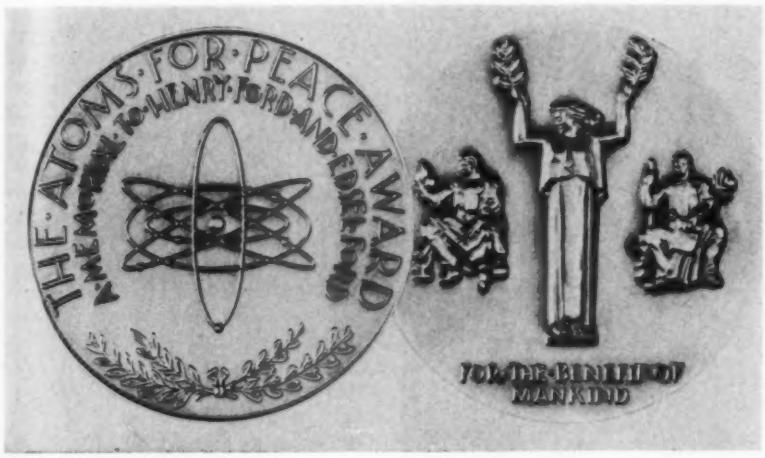
Volume 63, Number 7 *Edited at the Massachusetts Institute of Technology* *May, 1961*



THE ATOMS FOR PEACE AWARD—the gold medallion shown above and a $75,000 honorarium—was presented to Sir John Cockcroft during the observance of M.I.T.'s Centennial. Sir John was honored for promoting the use of isotopes, developing reactors, and advancing international co-operation.

Feedback

An Embarrassing Error

FROM JOHN C. ADAMS, JR., '48:

Since the middle part of last summer, I have known that something was wrong, but was not fully aware of what had happened until I turned to page 55 of the March, 1961, edition of your publication and noted my name in the deceased column, effective August 1, 1960.

Having solved this problem, however, a few additional problems have resulted. For example, if they decide to challenge the Marblehead vote in the recent presidential elections, they will find that someone has voted a gravestone name. More important perhaps to me personally is the fact that I have foolishly paid my 1960 income taxes on income received after August 1.

In all seriousness, I thought I had best advise you that I am very much alive and kicking and hope to remain status quo.

6 Elmwood Road
Marblehead, Mass.

[The Review apologizes to John Cecil Adams, Jr., '48, the author of the above letter, for omitting the middle name of John Curtis Adams, Jr., '48, of Fort Worth, Texas, whose death was reported to the Alumni Office.]

Kind Words Department

FROM CHARLES W. HOLZWARTH, '49:

I find I am reading The Technology Review and circulating it among my associates.

Please keep up the good work with your new format and content.

National Lock Company
Rockford, Ill.

EDITOR: Volta Torrey; BUSINESS MANAGER: R. T. Jope, '28; CIRCULATION MANAGER: D. P. Severance, '38; EDITORIAL ASSOCIATES: J. J. Rowlands, Francis E. Wylie, John I. Mattill; EDITORIAL STAFF: Ruth King, Muriel R. Roberts, Pauline Gates; BUSINESS STAFF: Madeline R. McCormick, Marianne G. Hagerty; PUBLISHER: H. E. Lobdell, '17.

The Technology Review is published monthly from November to July inclusive, on the 27th day of the month preceding the date of issue, by the Alumni Association of M.I.T.; Clarence L. A. Wynd, '27, President; H. E. Lobdell, '17, Executive Vice-president; Thomas F. Creamer, '40, William L. Taggart, Jr., '27, Vice-presidents; Donald P. Severance, '38, Secretary-Treasurer.

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Second-class postage paid at Concord, N. H.

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A hat similar to those shown in Fifteenth Century Venetian paintings was designed by Mrs. Helen Bottomly of the Department of Humanities for the Marshals at M.I.T.'s Centennial Convocation.

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Items that were news at M.I.T. 25, 50, and 75 years ago.

Individuals Noteworthy

George John Leness, '26

Charles Hard Townes

Corporation Member

THE ELECTION of George John Leness, '26, as a life member of the M.I.T. Corporation was announced on March 22 by Chairman James R. Killian, Jr., '26, Mr. Leness is the newly elected president of Merrill, Lynch, Pierce, Fenner and Smith, Inc., in New York, and previously served on the M.I.T. Corporation as an alumni term member, from 1949 to 1954.

Mr. Leness has been with his present firm since 1943, when he joined it as a general partner and head of the Underwriting Department. He became vice-president and chairman of the Executive Committee in 1959. He was previously associated with Harris Forbes and Company, Chase Harris Forbes Corporation, and the First Boston Corporation. He makes his home at 1185 Park Avenue in New York, and is a director of the Sinclair Oil Corporation and the Beekman Downtown Hospital.

Mr. Leness received a degree from Harvard as well as M.I.T., and is a member of Delta Tau Delta and Tau Beta Pi fraternities. His clubs include the M.I.T. Club of New York, the University Club, the Brook, and the Down Town Association.

M.I.T.'s New Provost

CHARLES H. TOWNES will fill the re-established Office of Provost at M.I.T., starting next fall. As Provost, he will be the senior academic officer reporting to the President and share responsibility with the President for general supervision of the Institute's research and educational programs. He will work directly with the Deans in furthering the programs of the several Schools, and will have primary concern for all inter-School activities, including the new interdisciplinary research centers.

A native of Greenville, S. C., Dr. Townes received his first degrees from Furman University and Duke University and his doctorate in physics at the California Institute of Technology in 1939. He then joined the technical staff of the Bell Telephone Laboratories, where he remained until his appointment to the faculty at Columbia University. At Columbia he later served as executive director of the Columbia Radiation Laboratory and chairman of the Department of Physics.

Dr. Townes is a member of the National Academy of Sciences, a fellow and member of the Council of the American Physical Society, a member of the American Philosophical Society, a senior member of the Institute of Radio Engineers, and of other professional and learned societies. He has been a Sigma Xi national lecturer, a Guggenheim fellow, and a Fulbright lecturer at the University of Paris and the University of Tokyo.

He has received the Comstock Award of the National Academy of Sciences, the Morris Liebmann Memorial Prize of the Institute of Radio Engineers, the Stuart Ballantine Medal of the Franklin Institute, and, most recently, the Rumford Premium of the American Academy of Arts and Sciences. He is editor of *Quantum Electronics,* published last year by the Columbia University Press, and the author of more than 100 books and scientific papers. His most widely known work relates to the theory and application of masers, on which he holds the fundamental patent.

Dr. Townes is currently on leave from his post as professor of physics at Columbia and is serving as vice-president and director of research for the Institute for Defense Analyses in Washington.

Faculty Promotions

THE EXECUTIVE COMMITTEE of the Corporation has approved the promotions of the following members of the Faculty to the rank of associate professor:

Judson R. Baron, '48, Aeronautics;

Amar G. Bose, '51, Electrical Engineering;

Gene M. Brown, Biology;

Gordon L. Brownell, '50, Nuclear Engineering;

Steven A. Coons, '32, Mechanical Engineering;

Peter S. Eagleson, '56, Civil Engineering;

Merton C. Flemings, Jr., '51, Metallurgy;

Moise H. Goldstein, Jr., '51, Electrical Engineering;

Martin Greenberger, Industrial Management;

Elias P. Gyftopoulos, '58, Nuclear Engineering;

Sigurdur Helgason, Mathematics;

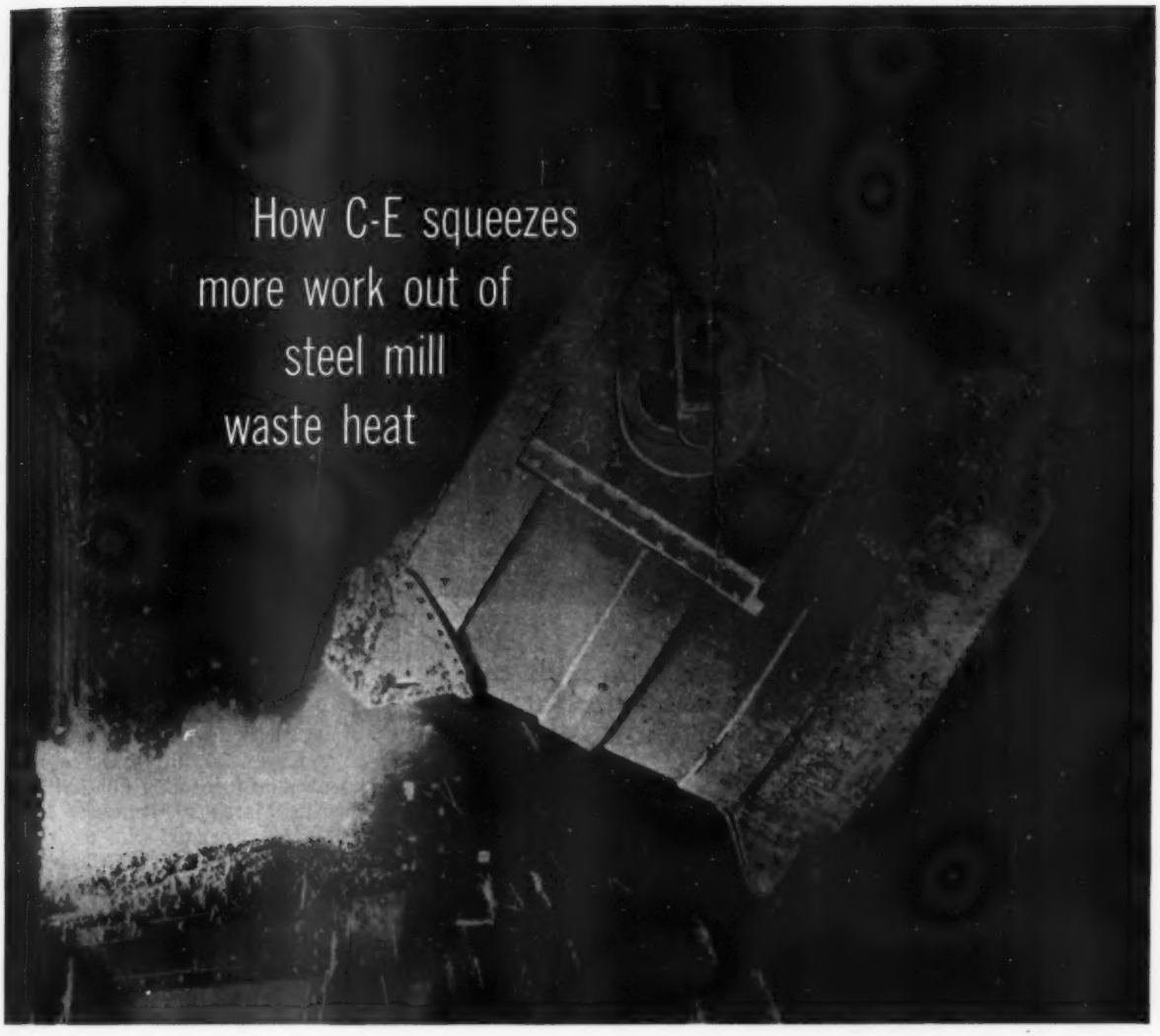
Kerson Huang, '50, Physics;

Kenneth A. Johnson, Physics;

Daniel M. Kan, Mathematics;

Jerome Y. Lettvin, '47, Biology;

(Continued on page 6)



Heat energy released in open hearth furnaces helps make more than 80 per cent of America's steel. In the process, much unused heat is discharged in the form of very hot gas from the open hearth exhaust.

Many kinds of waste heat boilers have been applied to the outlets of open hearths but their primary function has not been the efficient use of this excess heat energy. Rather, it has been their purpose to reduce the exhaust temperature so that the gas could be effectively cleaned in dust collectors prior to its discharge to atmosphere.

Combustion Engineering, experienced in the use of all kinds of marginal fuels and waste heat, and realizing the potential worth of open hearth gas as a power source, designed its Waste Heat Controlled Circulation Boiler—a truly *efficient* unit which makes *maximum* use of the tremendous energy in this gas.

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It can be tailored to fit difficult space conditions. In short, it is a dependable and efficient source of low cost power which, in the process of doing more work, effectively cools the gas so that it may be cleaned.

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A C-E Controlled Circulation Waste Heat Boiler, Type WCC, being shipped to a major midwestern steel mill. One of a number installed at this mill, it utilizes the heat energy in open hearth exhaust gas to provide dependable, low cost steam power.

C-310

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- **Strategic Communications**
- **Integrated Data Networks**

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COMMUNICATIONS:
- **Techniques**
- **Psychology**
- **Theory**

INFORMATION PROCESSING
SOLID STATE Physics, Chemistry, and Metallurgy

• **A more complete description of the Laboratory's work will be sent to you upon request.**

Research and Development
LINCOLN LABORATORY
Massachusetts Institute of Technology
BOX 28
LEXINGTON 73, MASSACHUSETTS

Individuals Noteworthy

(Continued from page 4)

John McCarthy, Electrical Engineering;

Arthur P. Mattuck, Mathematics;

Bruce Mazlish, Humanities;

Marvin L. Minsky, Mathematics;

Stanislaw Olbert, '53, Physics;

Franklin P. Peterson, Mathematics;

Irwin A. Pless, Physics;

Robert O. Preusser, Architecture;

Ernest Rabinowicz, Mechanical Engineering;

Norman C. Rasmussen, '56, Nuclear Engineering;

Richard D. Thornton, '54, Electrical Engineering;

Wallace E. Vander Velde, '56, Aeronautics;

Zenon S. Zannetos, '55, Industrial Management.

Joseph Kaye: 1912-1961

A NOTED AUTHORITY on generation of electricity directly from heat, Joseph Kaye, '34, Professor of Mechanical Engineering at M.I.T., died on March 20. Professor Kaye had been associated with the Institute since 1939, and was co-inventor of a thermo-electron engine.

Born in Malden, he received both his bachelor's degree and doctorate at M.I.T. and was for two years an A. D. Little post-doctorate fellow in chemistry. He became a research assistant in the Division of Industrial Coöperation in 1939, instructor in Mechanical Engineering in 1940, director of the Research Laboratory of Heat Transfer in Electronics in 1952, and a professor in 1955.

He collaborated on the production of *The Thermodynamic Properties of Air* (1945), and *Gas Tables* (1948), and was co-author of *Direct Conversion of Heat into Electricity* (1960). He was a fellow of the American Academy of Arts and Sciences and a member of several professional and honorary societies.

Professor Kaye is survived by his wife, Ida; his parents, Mr. and Mrs. Nathan Kaminsky; two brothers, Dr. Abraham Kaye and David Kaye; a sister, Mrs. Rose Levitts; and four sons, Leonard, Harvey, Sidney, and Charles, all of Boston.

(Continued on page 8)

Outstanding New Books from McGraw-Hill

INTRODUCTORY SYSTEM ANALYSIS: Signals and Systems in Electrical Engineering

By WILLIAM A. LYNCH, and JOHN G. TRUXAL, Polytechnic Institute of Brooklyn. The McGraw-Hill Electrical and Electronic Engineering Series. Ready now.

This work, the first of a two volume sequence, has been prepared primarily for the undergraduate course in Introductory Electrical Engineering and focuses attention to linear system analysis, electronic circuits and analog simulation and computation. A handy reference for practicing engineers seeking an introductory treatment of linear system analysis.

EXPERIMENTS IN HEARING

By GEORG VON BEKESY, Harvard University. McGraw-Hill Series in Psychology. $25.00

An eminent international psychologist and physicist makes available to physiologists and psychologists the results of his unique ground-breaking experiments in the field of hearing. Over the years, von Bekesy has created his own experiments and has established physiological and neurological facts concerning hearing which have advanced this field considerably. The book is based on most of the papers published by the author during the last 30 years.

SPACE ASTROPHYSICS

By WILLIAM LILLER, Harvard College Observatory. Ready now.

This book is the product of a lecture series given at the University of Michigan Department of Astronomy during the 1959-60 academic year on the aspects of astronomy and astrophysics which are concerned with or can be studied from outer space. Many of these lectures by leading space scientists are made available to students and scientists here for the first time.

HEAT TRANSFER

By BENJAMIN GEBHART, Cornell University. 454 pages, $10.75.

A senior level text and reference book containing a description of the physical processes, theories, and methods of analysis in the field of heat transfer. The theories and fundamental formulations of the three modes of heat transfer are followed by phase change processes, combined mode analysis, exchange design, and analogues. The physical nature of heat transfer processes is emphasized.

THEORY OF MACHINES

By JOSEPH E. SHIGLEY, University of Michigan. The McGraw-Hill Mechanical Engineering Series. Ready in June, 1961.

This is a combination volume of the author's KINEMATIC ANALYSIS OF MECHANISMS and his DYNAMIC ANALYSIS OF MACHINES (both available separately.) This is a junior-level text to bridge the gap between engineering mechanics courses and the professional courses in mechanical design. The tools of dynamic analysis are studied and used to synthesize and analyze the motions, velocities, and accelerations of many mechanisms. Then, a more useful tool is introduced, the three-dimensional unit vector approach, for the solution of space mechanisms.

METEOR SCIENCE AND ENGINEERING

By D. W. R. McKINLEY, National Research Council, Ottawa, Canada. Ready in May, 1961.

A technically sound and highly interesting review of the study of meteors slanted toward the radio engineer. Major emphasis is placed on the interesting and useful connections that have developed in recent years between the modern science of radio and the small flying particles known as meteors.

CONTROL OF NUCLEAR REACTORS AND POWER PLANTS. *Second Edition*

By M. A. SCHULTZ, Engineering Manager, Westinghouse Testing Reactor, Waltz Hill, Pennsylvania. 462 pages, $12.50.

A revision and up-dating of a unique book concerned with the use of servomechanism techniques as a method for the control of a nuclear power plant. The new material includes concepts that have arisen since the original publication, and the author has made some of the original ideas more applicable by including material on reactors other than the pressurized water type. Basic control problems of all types of reactors from homogeneous reactors to boiling reactors are handled.

SCIENCE IN SPACE

By L. V. HERKNER, Graduate Research Center, Inc., Dallas; and HUGH ODISHAW, National Academy of Sciences —Space Science Board. 458 pages, $7.00.

This new book comprehensively discusses the opportunities and problems presented by space. Much of the book is devoted to an exploration of the interests and needs of research in physics, astronomy, geophysics and geology, and the biological sciences.

SEMICONDUCTOR DEVICES AND APPLICATIONS

By RICHARD GREINER, University of Wisconsin. The McGraw-Hill Electrical and Electronic Engineering Series. Ready in May, 1961.

An advanced work explaining how diodes and transistors function and are used in circuits. A thorough discussion of the properties of semiconductors and junctions leads into an analysis of the transistor operation. Extensive application of the transistors to a variety of signal circuits, a detailed description of switching effects and switching circuits, and many completely worked example problems are included.

ELECTROMECHANICAL SYSTEM THEORY

By HERMAN E. KOENIG, Michigan State University; and WILLIAM A. BLACKWELL, General Dynamics Corporation. The McGraw-Hill Electrical and Electronic Engineering Series. Ready in July, 1961.

This pioneering work introduces into the literature of engineering a "discipline of lumped-parameter system analysis." This discipline is based on an expanded concept of conventional electrical network theory, and thereby brings into the domain of E. E. analysis a vastly broader scope of problems. The book develops the discipline, and shows specifically how a single set of engineering concepts is applied to the analysis of a wide variety of mixed systems.

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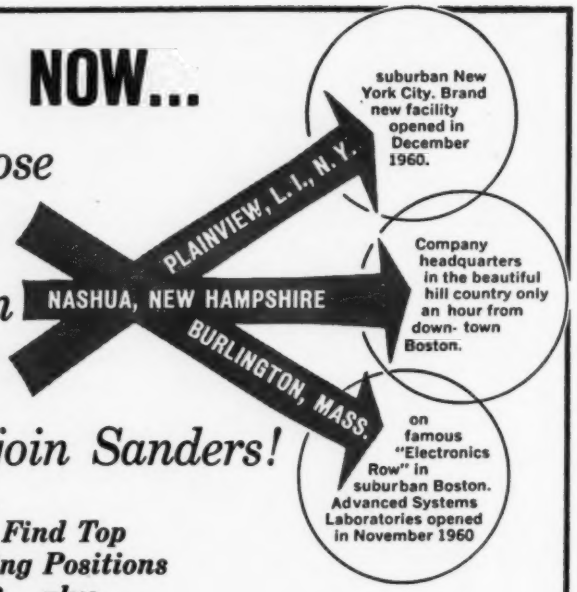
PLAINVIEW, L.I., N.Y.
suburban New York City. Brand new facility opened in December 1960.
NASHUA, NEW HAMPSHIRE
Company headquarters in the beautiful hill country only an hour from down- town Boston.
BURLINGTON, MASS.
on famous "Electronics Row" in suburban Boston. Advanced Systems Laboratories opened in November 1960

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Individuals Noteworthy

(Continued from page 6)

James McGowan: 1886-1961

A LIFE MEMBER of the M.I.T. Corporation, James McGowan, Jr., '08, died in Philadelphia on March 15. Mr. McGowan joined the Campbell Soup Company in Camden, N. J., as a chemist when graduated from the Institute and became its president in 1946 and chairman of its Board in 1950. He was born in Scotland on February 8, 1886.

He became an alumni term member of the M.I.T. Corporation in 1947, was elected a life member in 1952, and served on four Visiting Committees of that body.

He was a trustee of the Nutrition Foundation, Inc., a member of the Institute of Food Technologists, and at one time chairman of the executive committee of the National Canners Association. He also served on the advisory board to the Research and Development Branch, Military Planning Division of the Office of the Quartermaster General; and at the time of his death was a director of the Pennsylvania-Reading Sea Shore Lines and of the Philadelphia Manufacturers Mutual Insurance Company.

Mr. McGowan is survived by his widow, Elizabeth McGowan, and a son, James P. McGowan.

(Continued on page 46)

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You're probably one of the millions who have used such Union Carbide products as PRESTONE anti-freeze, EVEREADY flashlights and batteries, or PYROFAX bottled gas. But the major part of Union Carbide's output is in basic materials, employed by more than 50,000 industrial customers to fill your life with useful things.

The 70,000 people of Union Carbide operate more than 400 plants, mines, mills, laboratories, warehouses, and offices in the United States, Canada, and Puerto Rico. With these vast resources and skills, and the help of 35,000 suppliers, they create a variety of products in the fields of metals, carbons, gases, plastics, and chemicals.

It is men and women working together to provide new and better materials that gives full meaning to Union Carbide. And the people of Union Carbide, backed by 128,000 stockholders, will go on bringing you the necessities and conveniences that will help keep our standard of living the highest in the world.

Periodic Chart ©Welch—Chicago

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...a hand in things to come

Said Isaac Newton:

"Every particle of matter attracts every other particle with a force directly proportional to the product of their masses and inversely proportional to the square of the distances between them."

Until recently, the thrust which propelled rocket vehicles into their coast stage, prior to orbiting, was provided by booster stages. The fuel carried by the satellite stage was used only to inject itself into orbit.

Now, however, a scientist at Lockheed Missiles and Space Division has evolved a Dual Burning Propulsion System which allows higher orbits and heavier payloads. With this system, the satellite vehicle fires immediately after the last booster stage burns out, thus augmenting the begin-coast speed. Later the satellite stage is re-started to provide orbit injection.

An even more recent development by Lockheed is a triple-burning satellite stage. This will permit a precise 24-hour equatorial orbit, even though the vehicle is launched a considerable distance from the equator.

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EVIEW

Trend Of Affairs

The Institute Celebrates Its 100th Birthday

DEDICATED "to truth through science, proud of its concern for useful knowledge, and alive to a new order of ethical and social responsibilities," the Massachusetts Institute of Technology entered its second century last month. Those were the closing words of President Julius A. Stratton, '23, at the Centennial Convocation on April 9 in the Rockwell Cage—the climactic event of a three-day celebration of the 100th anniversary of the granting of the Institute's charter.

Throughout the three days scholars and statesmen debated the ends as well as the means of life in a world polarized around science. Speaker after speaker stressed the Institute's role as one of the world's most renowned places of education, and called on it for still greater contributions in its next century.

Prime Minister Harold Macmillan of Great Britain asked, in one of the weekend's memorable addresses, "Will man's destiny be fulfilled when once all men can satisfy their material needs?" The debate, he noted, goes on around the world.

"We are caught," said Secretary of State Dean Rusk, "in a period when a world we have known is disappearing and a world we are creating is just coming into being. . . . The language of science and scholarship eases transcultural discourse."

Ten thousand Alumni participated on campus in the observance of the Centennial, and more than 200 universities and scientific bodies, a fourth of them in foreign lands, were represented in the academic procession that preceded the Centennial Convocation.

President Kennedy's Message

SIR WINSTON CHURCHILL cabled his congratulations to the Institute and President Kennedy tape-recorded a message that Alumni and the Institute's guests heard at the banquet on the eve of the Convocation.

"We live at a time," said Mr. Kennedy, "when the old international tradition of the university is uniquely important. The Western universities originally derived their international tradition from their connection with the church. They now derive it because the world of ideas and the world of science are essentially international. If we are to produce the kind of world required for the safety and well-being of the human beings who live in it, we must build on this international tradition. . . . We must learn as national societies what the scientists already know—that the relations among men in the end must be as open as the relations now are between men of science."

James R. Killian, Jr., '26, Chairman of the Corporation, who presided at both the Convocation and the Alumni banquet, spoke on a similar theme. "M.I.T. opened its doors at the end of the Civil War and played its part in the great release of energy and growth that followed," he recalled. "May we not hope that our second century will see early in its course a similar opportunity, this time on the scale of the world community?"

Mr. Macmillan's Appeal

THE ADDRESS of Prime Minister Macmillan was a call for "a wider unity transcending traditional barriers" in the Western Alliance.

"The best, the cheapest, and the most sensible" road to security, he declared, would be genuine disarmament, but until it is achieved it is imperative that the Free World have a deterrent that is effective without being wasteful. The nuclear deterrent, he continued, is not yet so organized as to contribute fully to our unity, and the health of the NATO alliance requires that a way be found to build a partnership in nuclear as well as in conventional fields.

Turning to the market place and classroom, Mr. Macmillan observed that the Free World has three main problems: (1) how to maximize world trade, (2) how to organize assistance and capital to build up the less developed countries, and (3) how to finance an ever-increasing volume of trade and aid.

"We ought," he said, "to work for the largest area of free trade that we can create . . . There ought, ideally, to be a central banking system for all the countries of the Free World . . . Expanding trade needs expanding money . . . The nature of the struggle for the hearts and minds of men is such that no country, not even the greatest, can hope to stand alone."

Seen above, participating in a discussion televised during M.I.T.'s Centennial Week from the President's House, are (clockwise from left) Professors Jerrold R. Zacharias and Jerome B. Wiesner, Raymond C. F. Aron of the University of Paris, Charles Collingwood, Sir Eric Ashby of Cambridge University, Dr. I. I. Rabi of Columbia and Dean John E. Burchard, '23. *(A Christian Science Monitor photo)*

The International Conference

FOR FOUR DAYS, prior to the general assemblies held to celebrate M.I.T.'s Centennial, scholars and leaders in many disciplines, from many nations, met to ponder problems of scientific and engineering education, the interactions of science and engineering with society, and the implications for international relations. Their discussions were summarized for Alumni and friends of the Institute at the first general assembly by members of the M.I.T. Faculty.

In opening this assembly, Dean John E. Burchard, '23, chairman of the Centennial, explained that the Institute now feels a triple obligation: "To help to advance the boundaries of scientific knowledge, to help put this knowledge to work, and, most difficult of all, to help to see to it that the outcome of the work is benign."

Professor Max Millikan, Director of the Center for International Studies, reported on the discussion of the newly developing nations' problems. These countries, he said, require a wide spectrum of scientific and engineering talent, and the key bottleneck in meeting their needs now appears to be the lack of adequate personnel to assist them.

Professor Martin Deutsch, '37, of the Department of Physics, reporting on discussions of the advanced countries' problems, said the need for engineers had been especially emphasized, and that it was felt that the increasing complexity and rapidity of developments in engineering "would change the face of engineering education in all of the advanced countries."

Professor Elting Morison of the School of Industrial Management was the reporter for conferees concerned with interactions of science, engineering, and society. They felt, he said, that the rate of change was "the most significant fact about the world today," and had asked him to convey to the Centennial audience "a sense of the excitement of living in at least two different cultures, three different countries, and four stages of history, all at the same time."

Walter A. Rosenblith, Professor of Communications Biophysics, concluded these reports with a review of the implications of science and engineering in international relations. The conferees on this topic, he said, had lamented the lack of support for such organizations as the International Council of Scientific Unions, and had pointed out that CERN (The European Organization for Nuclear Research) represents "a new kind of international institution."

The Secretary of State, Dean Rusk, re-emphasized points made in the international conference in his address at a general assembly. To a considerable extent, he said, foreign policy is in the hands of people themselves, and the "international community of science and scholarship" plays an important role in our foreign relations.

Historically, Dean Rusk noted, human needs have been a cause for war, but now nations and peoples seem to be pinning their hopes on science and technological developments. Hence, he argued we must make, "tolerable advances." We are committed, he said, "to a job of building," and to succeed we must "elevate our sights as to the role of education."

In The Review Next Month

FURTHER REPORTS on the events arranged to observe M.I.T.'s Centennial, including the full text of Prime Minister Harold Macmillan's address, President Stratton's response to the greetings, and reports on the panel discussions prior to the convocation, will be published in the June and July issues of The Review—with many photographs.

The Solar Wind Is Found

A CLIMAX to much work in the Laboratory for Nuclear Science at M.I.T. came this spring when Explorer X detected a "solar wind." It consists of electrically neutral streams of magnetized, ionized particles apparently emitted from the sun in masses which interact with interplanetary magnetic fields, and this wind was found with a plasma probe designed and assembled at the Institute. The probe was carried about 140,000 miles from the earth in a satellite launched March 25 from Cape Canaveral.

The 78-pound satellite also carried magnetometers from the Goddard Space Flight Center, which revealed the existence of considerably stronger magnetic fields than had been expected at distances beyond 60,000 miles from the earth.

Interactions between the plasma and these fields are on a scale that cannot be duplicated on earth. Hence, they interest not only communications engineers and prospective space travelers, but all physicists, cosmologists, meteorologists, and other scientists whose work involves magnetohydrodynamics.

The findings of the instruments on Explorer X were transmitted to tracking stations around the world for nearly 60 hours, although the batteries which powered the transmitter had been expected to last only about 55 hours. The Blossom Point, Md., Minitrack Station's records were the first ones examined, and a "quick look" at them was sufficient to indicate to the scientists directing the experiment that it had been successful. Further analysis of the abundant harvest of data is under way.

The plasma probe was built by Herbert S. Bridge, '50, Frank Scherb, '53, and Alan J. Lazarus, '53, of the Laboratory for Nuclear Science, and Ervin F. Lyon, 3d, '59, of Lincoln Laboratory. Professor Bruno Rossi, the Institute's internationally known expert on cosmic rays, directed the interplanetary plasma project, and the National Aeronautics and Space Administration's project manager for the shot was Dr. James P. Heppner of the Goddard Space Flight Center.

This was the first of two experiments in space this spring which were planned at the Institute.

Tuition Increase in 1962

STUDENTS were notified this spring that tuition at M.I.T., which is now $1,500, will be increased to $1,700 in the summer of 1962, to raise salaries of the teaching staff. Tuition still will cover less than one-half the cost of educating each student. "M.I.T.," President Stratton pointed out, "must support a salary schedule that is on a par with the best of other educational institutions."

The World's Greetings

THERE were 600 marchers in the academic procession that Chief Marshal David Allan Shepard, '26, led across Massachusetts Avenue when the trumpets sounded on April 9 for the Centennial Convocation. Mr. Shepard carried the mace and wore a new scarlet robe and hat, designed for the occasion, and the gowns and hoods of nearly all the world's great schools were in the line of march behind him. The day was fair, and in addition to the throng present thousands saw the procession on television.

Mrs. Karl Taylor Compton gave the invocation. Greetings to the Institute then were delivered from the Commonwealth of Massachusetts by Governor John A. Volpe; from American universities, by President Harlan H. Hatcher of the University of Michigan; from foreign universities, by Professor John Fleetwood Baker of the University of Cambridge; from students, by Joseph Harrington, 3d, '61; from Alumni, by their Association's President Clarence L. A. Wynd, '27; and from the Faculty, by Institute Professor John Clarke Slater. The response of the Institute was given by President Stratton.

Music for the occasion by the M.I.T. Concert Band, the Choral Society, and the Boston Brass Ensemble included a Centennial Overture written by Gregory Tucker, Associate Professor of Music, and fanfares composed by Andrew Fenton Kazdin, '57.

An Intellectual Feast

ATTENDANCE at M.I.T. Centennial events reached a peak on Saturday morning, April 8, when panels of scholars discussed how science has changed man's view of himself, the future of the arts in a world of science, and the future of the physical sciences.

That afternoon other panels considered the difficulties of arms control, the life of man in industry, and the future of the life sciences.

Because of the throng interested in the discussions of science, two of the groups were transferred from the Compton Lecture Hall to the Armory. Closed-circuit television carried the proceedings to tents pitched near the Kresge Auditorium, and to many of the Institute lounges. A large TV screen in the Kresge Auditorium proved especially attractive to many unable to obtain seats up front in the Cage.

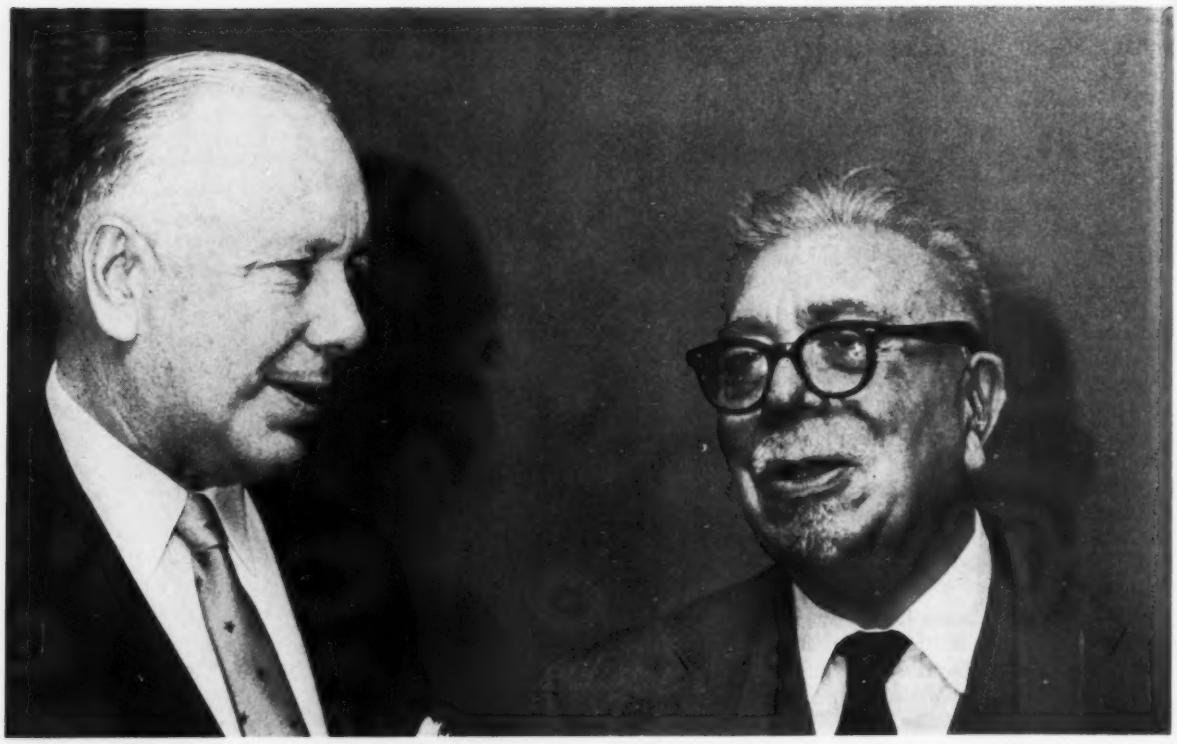
Vannevar Bush, '16, Alfred P. Sloan, Jr., '95, James McCormack, '37, and John J. Wilson, '29, at the Convocation.

Chief Marshal Shepard, '26, led scholars from every part of the world in the Centennial academic procession on April 9.

The Salute to Mr. Sloan

SECOND CENTURY FUND leaders at M.I.T. for the Centennial ceremonies honored Alfred P. Sloan, Jr., '95, their honorary chairman, at a breakfast in the Statler, and heard that approximately half of the $66,000,000 being sought had already been pledged.

An unscheduled speaker was the President's Special Assistant for Science and Technology, Jerome B. Wiesner, who pointed out that the problems he faces from the White House have long been considered at M.I.T. Others who spoke included President Stratton, John J. Wilson, '29, general chairman of the Fund, and Philip H. Peters, '37, chairman of the Fund's Area Organization.



President Julius A. Stratton, '23, and Institute Professor Norbert Wiener—a symbol of excellence to his M.I.T. colleagues.

The Legend of Norbert Wiener

FOR 42 of the Institute's first 100 years, Institute Professor Norbert Wiener has been a familiar figure in its corridors and a dominant one in its traditions. This spring, on his return from Europe, his colleagues in the Department of Mathematics, the Research Laboratory of Electronics, and the Center for Communications Sciences, gave him and Mrs. Wiener a silver bowl "in recognition of his outstanding service to M.I.T. and the world of science."

President Julius A. Stratton, '23, joined them in recalling "those long equations that started over here and went all the way around," and in praising his enormous productivity, the great variety of his interests, and his concern for the social implications of science and mathematics.

William Ted Martin, Head of the Department of Mathematics, stressed the high, hard standards set by Professor Wiener in mathematical work, his emphasis on the importance and dignity of the individual, and his discernment of a central, unifying theme in all branches of mathematics and the relations of mathematics to other fields of science and engineering.

Jerome B. Wiesner, President Kennedy's science adviser, speaking for the Research Laboratory of Electronics, referred to Professor Wiener as "the conscience" of his group, and Professor Peter Elias, '44, pointed out that Professor Wiener had contributed to "a good half of what electrical engineers are interested in nowadays."

The American Mathematical Society was represented by Professor Richard Brauer, chairman of the Department of Mathematics at Harvard, and the Institute of Radio Engineers by its retiring President, Ronald L. McFarlan. In a telegram read by Professor Walter A. Rosenblith, the International Brain Research Organization announced the election of Professor Wiener to honorary membership.

"It is difficult," said Dr. Stratton, "to grasp the really extraordinary changes that have taken place in the Institute, not only in its size, laboratories, buildings, and budget, but in its character. Through these changes, M.I.T. has evolved from a rather small institution with a particular motivation to what we may, quite clearly, call a scientific university. And during this whole period of change and transition, Norbert Wiener has stood as a symbol of all we thought best in the academic world."

Planning for Venezuela

THE GOVERNMENT of Venezuela has arranged for research and technical assistance from the Joint Center for Urban Studies of M.I.T. and Harvard in developing the Guayana region. This area near the confluence of the Orinoco and Caroni rivers has been called the Ruhr of South America because of its great natural resources. Some 45,000 persons already have moved into the region in anticipation of its development. A steel mill to be managed by Koppers is being built and an aluminum plant, a petrochemical plant, and other factories are being planned now.

A new city of 200,000 or more is expected to rise and the Joint Center will help determine the requirements for housing, industry, and public services in this city as well as in the region as a whole. It will examine problems of public and private financing, study the region's potential, and analyze its probable pattern of growth. Work will begin both in Venezuela and Cambridge as soon as a project director has been appointed.

(The Trend of Affairs is continued on page 40)

Future Men and Machines

AS A CONTRIBUTION to the observance of M.I.T.'s Centennial, the School of Industrial Management is presenting eight lectures this spring on "Management and the Computers of the Future." Here are short reports on the first of these lectures. All will be published later in book form. The last four lectures in the series are to be given this month in Kresge Auditorium at M.I.T.

A Computer Console For Every Freshman?

THE ULTIMATE ROLE of the computer as handmaiden to scholarly university activities can be far greater than it is now, Professor Alan J. Perlis, '49, contended in the first lecture of an M.I.T. Centennial Series on "Management and the Computer of the Future." Professor Perlis, who was a research mathematician with "Project Whirlwind" at M.I.T. in the 1940's, is now director of the Computation Center at the Carnegie Institute of Technology and chairman of the American committee on ALGOL (algorithmic language), an international programming language.

A university graduate, he said, in opening this lecture series, should have received "training directed to the development of sensitivity, rationality, and an intelligent table look-up procedure. The first, as the poet MacLeish has so aptly said, is for the development of a feeling for the meaning and relevance of facts. The second, for the development of fluency in the definition and manipulation of convenient structures, experience and ability in choosing representations from the study of models, and self-assurance in the ability to work with large systems. The third, of course, is the catalogue of facts and problems which give meaning and physical reference to man's role in society.

"While the computer may conceivably play a small role in the development of human sensitivity, it is quite critical to the other developments. Indeed, no other mechanical instrument combines so well the theoretical and practical balance necessary to these developments."

More than 100 high-speed electronic computers already are at work in American universities and more are being installed. They are used mainly for computations in research programs. "With only a few users does the computer itself —or more precisely, the insight it takes to use it—invest a deeper interpretation of the development being studied," Professor Perlis said. "In general, graduate students' contact with the computer merely sharpens differences in ability among them already noted from other evidence. The intellectually sublime become more poetic on the computer, while the dull become what can only be called monumental machine bores."

To make better use of computers as teaching devices, the lecturer advocated that engineering and science students be brought into contact with them as college freshmen, and liberal arts students as sophomores. The introductory course he envisages, moreover, would be technical and not purely descriptive. "At least in engineering and science freshman programs," Professor Perlis maintained, "This course should share with Mathematics and English the responsibility of developing literacy, while Physics and Chemistry develop the background toward which this literacy is to be applied."

What should the student be taught about programming in such a course? Professor Perlis suggested that it cover such fundamentals as parametrization, iteration, recursion, definitions, a priori attention to eventualities regardless of likelihood, representation, mechanical language, simulation, and proof.

In such a course, he continued, it would be important that the student be graded quickly and guided. Computers now can do the grading

SOME FRESHMEN have brought their own computers to M.I.T. This one, which plays checkers, is now in Boston's Museum of Science. David Ecklein, '63, its builder, is shown explaining it to a museum visitor.

in a generally satisfactory way. They cannot yet do a good job of identifying mistakes in programming and isolating sources of misunderstanding, but there is no reason they could not be made to employ diagnostic information acquired while grading to produce corrective problem sequences.

"Both explanatory text and problem statements may be individually printed for each student through a high-speed printer," he suggested. "More importantly, the grading program can maintain counts of the frequency of use of text branches, so that sensible improvements can be made in the organization of the net of problems and solutions."

At Carnegie Tech, Professor Perlis reported, a program causing a computer to behave like a teaching machine is currently being developed to teach the syntax of a programming language.

"The first and most critical stage of the computer's role in the university, it seems, is clear," he said. "It is to train entering students in the theory of computation through the development of the concepts of programming. To do this the computer plays a partner's role with the teacher in sequencing the student through a set of problems . . .

"At the completion of this first course, the student should be able to recast his learning of, say, calculus so as to be able to devise mechanical methods for a computer to differentiate elementary expressions and quite naturally to make the separation between the introduction and consequence of definitions and the mechanical manipulation he does so much of. The concept of the teaching program for calculus should not only appear natural but so should the planning procedure for accomplishing it. To be sure, maturity in relating mathematical developments, e. g., that of algebra and calculus in the integration of rational functions, is still not developed; but such as it is the maturity will be applied to an intellect already attuned to the rationale of process definition and synthesis."

Students, he predicted, would attack with interest the problem of creating a technician within the computer to do mechanical analysis. Such a technician could do "the dirty work" in the tiresome manipulations required by many problems.

The programming language needed to make the computer such a technical aid will require more flexible notational abilities than any now extant, Professor Perlis said, but should be developed in university computing centers.

Of course, he added, the computer must have such salient features as high-speed, multiple inputs and outputs, and large random access storage units. Remote consoles also will be needed, so that many students may have simultaneous access to a machine.

Professor Donald G. Marquis introduced Professor Perlis and presided over a lively discussion in which Professor Peter Elias, '44, emphasized the importance of efforts to adjust machines to people, and J. C. R. Licklider suggested that better poetry will be written some day in the language of digital computers than ever has been written in English.

How Will Computers Affect Management?

ENTERPRISE ENGINEERS soon will be the men most in demand by industry, Professor Jay W. Forrester, '45, said in the second of the School of Industrial Management's series of Centennial Lectures on management and computers.

Professor Forrester viewed industrial organizations from a perspective between that of the psychologist concerned with individuals and the economist viewing events from afar, and described managerial decision-making as a feed-back system similar to those found in electrical and biological systems.

"The manager," he said, "is a person to whom information flows and from whom come streams of decisions which control actions within the organization. Management success depends primarily on what information is chosen and how the conversion is executed . . .

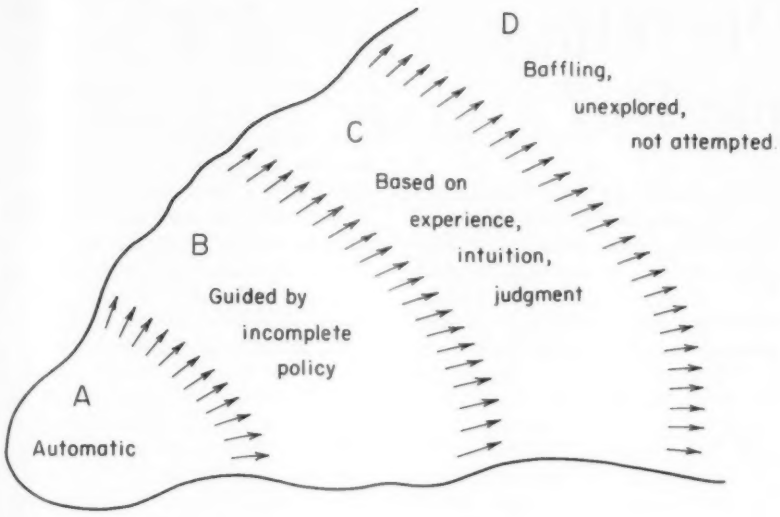
"An industrial organization is a complex interlocking network of information channels. These channels emerge at various points to control physical processes such as the hiring of employees, the building of factories, and the production of goods. Every action point in the system is backed up by a local decision point whose information sources reach out into other parts of the organization and surrounding environment . . . The regenerative process is continuous and new results lead to new decisions which keep the system in continuous motion."

At the decision points, he continued, men see the apparent state of actual conditions and attempt to bring them closer to desired conditions, but the entire process is "highly nonlinear and noisy."

Much of the literature of economics deals with the policy followed at decision points, and much of history and literature devotes itself to the basis of policy which causes the human decision-maker to react in a reasonable and expected way to his environment. "In physical systems, particularly in the field of servomechanisms, the corresponding term is 'transfer function,'" said Professor Forrester. "The transfer function tells how the output of a particular box depends on the stream of inputs. . . .

"In industrial organizations, some policy is very formal. But informal policy may be every bit as influential. It depends on habit, conformity, social pressures, ingrained concepts of goals, awareness of power centers within the organization, and personal interest."

From Professor Forrester's perspective, management decisions can be classified according to the form of controlling policy. Some decisions such as those based on rules for accounting and giving shipping instructions already are made on a fully automatic basis by machines, and this area is expanding. A second category of decisions, made by a vast bureaucracy of middle management, consists of those based on well-understood policy which have not yet been mechanized. In a third category are decisions, usually made nearer the top levels of the



The boundaries between decision regions move out and upward.

organization, where action is based on experience, intuition, and judgment. And beyond these there is a region of great challenge where no basis of action in either experience or intuition is really known.

"The dividing lines between these regions are not sharp," he said. "The gradation from the automatic decision to the one that lacks even a basis in experience and intuition is one of continuous and gradual transition. The dividing zones between regions, however, are moving upward and outward."

The middle regions immediately above those where decisions are completely formal, he continued, are not such obscure and subtle jungles as they often seem. "If we can understand the mechanisms of a social system," he explained, "we can construct effective and useful dynamic models of its operation. These models open the way to what is essentially a management laboratory.

"The design of a corporation with its organization structure and its managing policies can be brought to a level not unlike that of the design of an airplane with its wind tunnel and its aircraft models. It opens the way to what we might call 'enterprise engineering' for the design of organizations to meet specific objectives and goals."

Is there any reason to do this?

"One can point to the large number of new industrial enterprises which are founded but to fail," Professor Forrester answered. "On the other hand, there are those which begin and flourish with a growth rate of as high as 50 or 100 per cent per year. When the range in dynamic behavior is this great, there must indeed be some fundamental underlying reasons for success which can be better understood."

We have, he continued, tremendous examples of accomplishments in the understanding of military control systems in the last decade, and some preliminary examples of what can be done by the same approaches to industrial systems. In the next level of progress in economic development, he believes, art and intuitive judgment will be applied to the development of a better understanding of policy.

"This does not imply automatic management," he emphasized. "A better understanding of decision-making policy and its information-feed-back content will not reduce the demands on the executive. Quite the reverse. He will have new methods to use and a new theoretical underlying structure to understand, and the more skillfully these tools are selected and the more significant the goals, the more effective will be the application.

"New advances in physics have not led to automatic engineering. The skilled system engineer still produces the better chemical process or earth satellite.

"We can see, however, that the emphasis in the corporation will change. Recognition of the importance of policy can be expected to spread very rapidly . . . There will be a thinning out of the present middle management operation. Much of the middle management structure is made up of frustrating and unrewarding tasks. As these tasks are better understood, it will no longer be necessary to squander the talents of good men in these positions.

"The analogy to the physical product production line is excellent: As the production process became routine, two things happened. Work on the production line became unrewarding. Also, once the tasks were fully understood, it became possible to design machines which would serve the function as well and not suffer boredom. . . .

"At the stage which we are now entering, the art of machine design is being formalized into logical rules. We can call this the automation economy. At this level, man designs methods and procedures which will permit machines to design machines which in turn will produce for human consumption. We have already taken a substantial step in this direction: Digital computers are today designed by digital computers. Computing machines design mechanical parts and lay out the piping and structure for chemical plants. The creative designer works with the formal concepts that govern how design should be done.

"At the next level, which we might call the 'artificial intelligence' level of economic development, machines will perhaps be instructed in how to develop the design concepts which machines can then follow to produce designs to produce equipment to produce goods for human consumption. . . .

"The manager, in rising to a new level of abstraction where he concerns himself with formal decision-making policy and with enterprise design, will be keeping pace with the evolution of our technological society."

Robert C. Sprague, '23, chairman of the Sprague Electric Company, presided on the occasion of this lecture and the discussants were Professors Charles C. Holt, '43, of Carnegie Tech and Ronald A. Howard, '55, of M.I.T. Much of the discussion dealt with distinctions between the approximately five-year-old science of industrial dynamics and the about 20-year-old science of operations research.

Do Machines Operate The Way People Do?

IT IS no longer debatable whether computers can simulate human thinking, Professor Herbert A. Simon, Associate Dean of the Graduate School of Industrial Administration at the Carnegie Institute of Technology, contended in the third of the M.I.T. Centennial Series of lectures on computers and management in the future.

"A dozen or more computer programs have been written and tested that perform some of the interesting symbol-manipulating, problem-solving tasks that humans can perform and do so in a manner which simulates, at least in some general respects, the way in which humans do these tasks," he said. "Computer programs now play chess and checkers, find proofs for theorems in geometry and logic, compose music, design electric motors and generators, memorize nonsense syllables, form concepts, learn to read . . .

"Computer programs can be written that use non-numerical symbol-manipulating processes to perform tasks which, in humans, require thinking and learning. These programs can be regarded as theories, in a completely literal sense, of the corresponding human processes. These theories are testable in a number of ways: among them, by comparing the symbolic behavior of a computer so programmed with the symbolic behavior of a human subject when both are performing the same problem-solving or thinking tasks."

Professor Simon, who is now on leave of absence with the RAND Corporation, is noted both for work in the social sciences and with computers. He was formerly on the faculty of the Illinois Institute of Technology, and has been the author or co-author of many books, including *Models of Man: Organizations* (1957) and *The New Science of Management Decision* (1960).

Professor Simon's lecture dealt particularly with a program which is called the General Problem Solver because it can employ a system of methods, believed to be those commonly used by college students, to work on any problem that can be put in a specified but fairly general form. This system, he argued, is basically similar to the way a child learns to speak, the way a mathematician solves problems, and the way a businessman makes decisions.

"The child acquires perceptual auditory symbols corresponding to words he has heard and associated with visual symbols," Professor Simon explained. "He tries, on a trial-and-error basis, to produce words, hears his productions, and compares these auditory symbols with those already stored. When he detects differences, he varies the motor symbols to try to remove them. As he learns, he detects that changes in certain components of the motor symbols alter only certain components of the auditory symbols. Thus he is able to factor the correction process and thereby accelerate it greatly."

A discussion of "What Computers Can Do Better" (on May 22) will conclude the Centennial Lecture series reported on these pages. Shown here with a machine's arm is Professor Claude E. Shannon, '40.

This, in effect, he went on, is the way that living organisms survive. They associate appropriate perceptual symbols and motor symbols. The former describe the world as it is and as it is desired, and the latter describe possible actions. Each set of symbols is a kind of internal language, and how hard a problem is depends on the simplicity or complexity of the rules that define the correspondence between the symbols that constitute these languages.

As an example of a relatively simple correspondence between symbols, Professor Simon cited the relation between the decimal and octal representations of integers. There is a simple and direct algorithm that solves all problems in translating decimal representations into octal representations. But in other cases the correspondence between the vocabularies of two different languages may be purely conventional or arbitrary. Rote learning is the only means of building up a translation dictionary then, and immense amounts of trial-and-error searching may be required.

"The aspects of the environment with which we, as organisms, deal effectively reach neither of these two extremes," Professor Simon said. "The translation between the 'state' language that describes our perceptions of the world and the 'process' language that describes our actions on the world is reducible to no simple rule, but it is not arbitrary. Most of our skill in dealing with the environment is embodied in elaborate heuristics, or rules of thumb, that allow us to factor (approximately) the complex perceived world into highly simple components and to find (approximately and reasonably reliably) the correspondences that allow us to act on the world predictably."

The General Problem Solver program, he concluded, describes the core of these heuristics. Hence, in such a program, he said, we now have a first approximation to what Walter Pitts of M.I.T. has described as "the hierarchy of final causes traditionally called the mind."

Professor Sidney S. Alexander of the School of Industrial Management presided on the occasion of this lecture, and the commentators were Professors George A. Miller of Harvard and Marvin L. Minsky of M.I.T.

How Will You Obtain A Book in 2000 A.D.?

A NATIONAL LIBRARY with more information in it than Harvard's —all almost instantly accessible on a viewing screen hundreds of miles away—was described by Professor John G. Kemeny, Chairman of the Mathematics Department at Dartmouth, in the fourth lecture of the M.I.T. Centennial Series on management and computers.

This library for 2000 A.D. would start with 10 million volumes and possibly grow to 300 million within the Twenty-first Century. Each page of each "book" in it would be stored on possibly a square millimeter of tape. The library would serve 100 or more universities, each of which would have a multitude of viewing screens. Using the library would be similar to making a long distance telephone call: When the patron dialed the correct code number, the reference he wished would appear on his viewing screen.

Such a library will be needed, Professor Kemeny argued, because if the present rate of growth continues our richest universities will be unable to afford building, cataloguing, and serving the kind of libraries they have now. These libraries, he declared, already are practically obsolete, certain to be so by the end of the Twenty-first Century, and will be useless for most purposes by 2000 A.D.

"The library of the future," he said, "will have to make use of automation. There is no conceivable way in a library of several tens of millions of volumes that human effort could locate an item in a matter of minutes. . . . Storage methods must miniaturize books and put them on a medium easily handled by machines."

Even though an automated national library might cost a billion dollars, he continued, it should be able to serve a great many universities in all parts of the country—and do so more economically than they could all maintain separate libraries of their own.

Of course, Professor Kemeny conceded, some readers would object to being deprived of the pleasures of browsing. But their needs could be met by having a few hundred thousand old-fashioned reference works, current periodicals, etc., on local shelves.

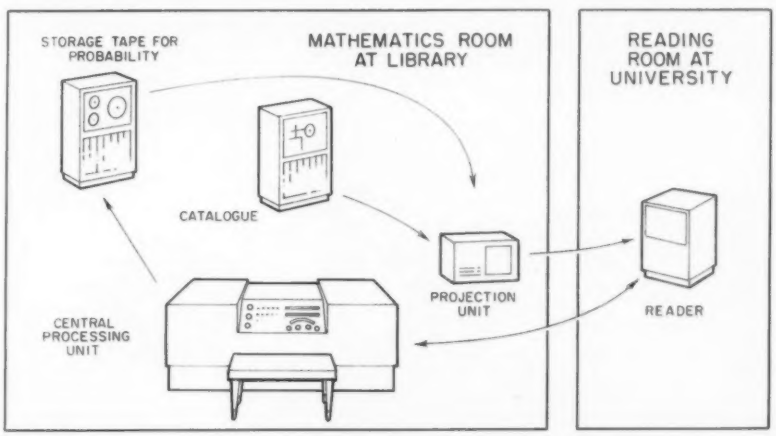
The big national library's contents would be divided into subjects, which in turn would have branches, and these would consist of items, all having code names. ABC-12-34567-89, for example, might be what you would dial to get Item Number 89 in Volume 34567 of Branch 12 of Subject ABC. But suppose you got a busy signal?

Professor Kemeny would reduce that possibility by not allowing customers to use items directly from the files. Instead, each person requesting a book would receive a copy of it. The item asked for would be transferred from the storage tape to a projection unit and sent, conveniently magnified, to a tape in the reading unit of the person desiring it. With $10 worth of tape, a customer could have a 10-volume collection of personally selected items; and if he tired of them, he could simply erase the tape and have a new set of books flashed to him from the master tapes in the central library.

One day of each month, however, each branch of the central library might have to be closed for updating, extension, and repair of its master tapes. This, of course, would be only a slight inconvenience.

In addition to describing such a library, Professor Kemeny discussed the problem of assisting the researcher searching the literature on a given topic. By dialing information, he suggested, the national library's patrons might be put in touch with an information-searching machine. This, however, is an aspect of the problem which Professor Kemeny feels still calls for considerable study.

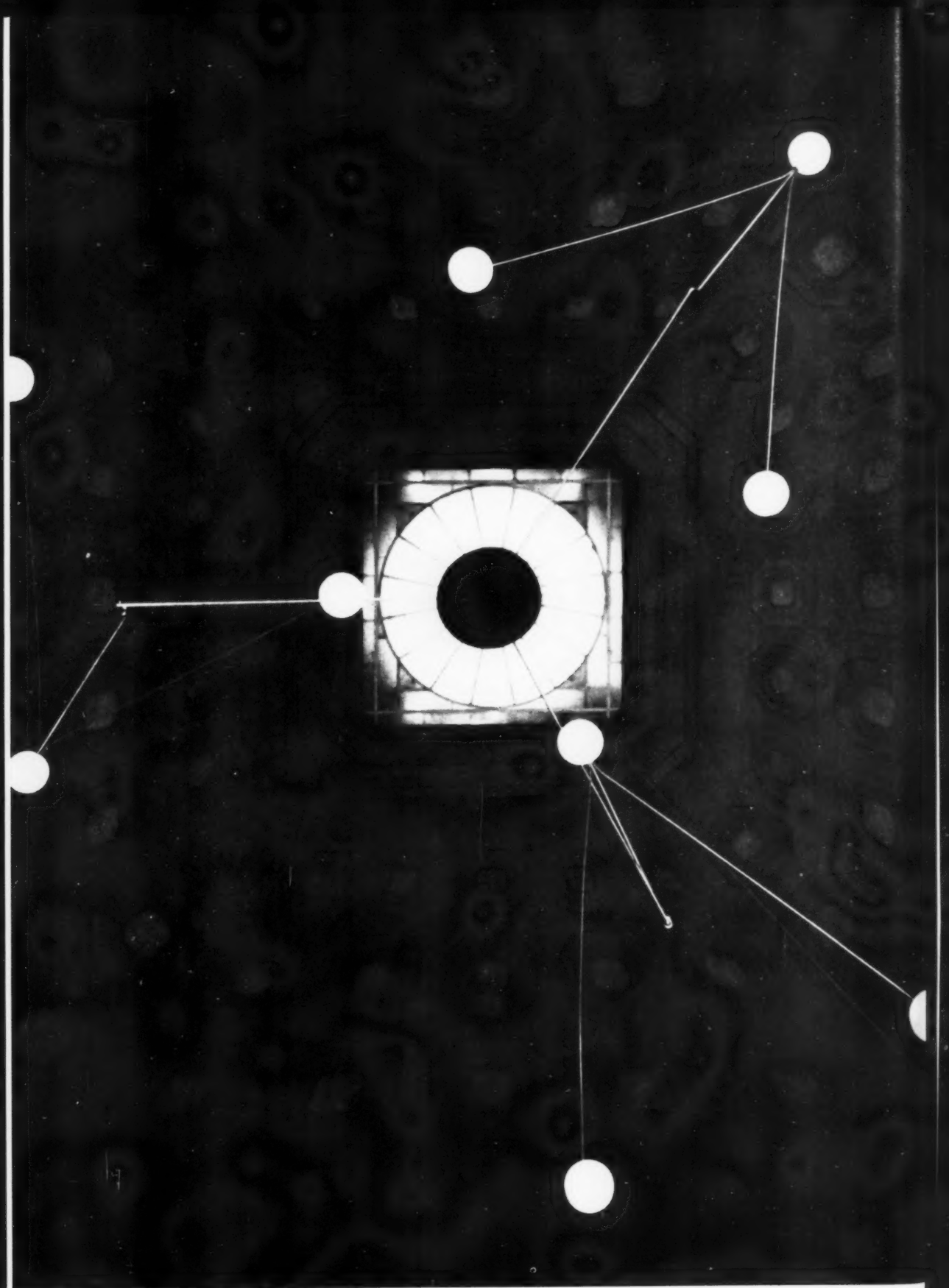
"I find the concept of such a library very attractive," he said. "I am basically a lazy person. I would like to sit in my office and have access to a book with no more trouble than calling a friend on the phone long-distance. . . . We would get busy signals less often than the frequency with which the book we are looking for is out of our library today. And we could arrange our calling system so that we could hold on and obtain access to a storage tape as soon as it was freed—which should be within minutes.



A book on probability may sometime reach you via this route.

"I am particularly attracted to the prospect of combining this automated library with machine-search. . . . It is possible that, even with all this elaborate mechanization, information retrieval will become hopeless in 100 years—but without mechanization we won't have a ghost of a chance."

Professor William N. Locke, Director of Libraries at M.I.T., presided during this lecture and the discussion which followed. Commentators on the idea included Professor Robert M. Fano, '41, and Gilbert W. King, '33, Director of Research for IBM. The daily newspapers paid especial attention to this lecture.



A University's Proper Heritage

A Center for Materials Science and Technology at the Institute should rekindle the spirit of adventure, comradeship, and joy in discovery

BY ARTHUR R. VON HIPPEL

FEW MEN are as well qualified as Professor von Hippel, Director of the Laboratory for Insulation Research at M.I.T., to speak of the problems and potentialities of interdepartmental research centers. He has done so in previous articles for The Review (See, "Molecular Engineering," March, 1956; "Answers to Sputnik?" March, 1958; and "Universities in Transition," April, 1959). In this article he points out similarities and differences between modern requirements in medicine and those in the field of materials science and technology.

THE technical competence and political maturity of a country are reflected in the methods and policies it adopts for the use and safeguard of nature's resources. Much has been learned and much destroyed in the passing industrial age motivated largely by thought of immediate gain, without much concern for life on this planet. Only the rapid progress of science and technology rescued our civilization again and again from critical impasses of its own making.

Our understanding has advanced sufficiently in many fields to attempt a synthesis of knowledge and to foresee in wider perspective the consequences of our actions. Scientists and engineers, previously confined to airtight subdivisions, are discovering in molecular concepts a basis of true alliance. Economists, ecologists, and medical doctors are experiencing the exciting advantages of group co-operation. The growth of interdepartmental research centers and interdepartmental teaching has begun to transform our universities. As their new students enter the various professions, they will help to break old prejudices and will cause society to act under wider horizons.

The creation of interdepartmental research centers is more than an act of administrative decision. It requires the clear formulation of new goals, the recognition of new forms of organization implementing this vision, and—last not least—faculty groups eager and able to undertake the new venture. In the field of materials science and technology the formation of an interdepartmental center at M.I.T. approaches realization. It is necessary, therefore, to sharpen the general concepts advanced previously into clear proposals that can become the subject of faculty debate and administrative action. This paper, in summarizing a private opinion on this issue, hopes to enliven the debate.

Mayo Clinic of Materials Research?

American and English law finds guidance by precedent. A precedent in organizing effective co-operation between specialists has been set by the medical profession. Cause and effect of this recent development will give some guidance for our action.

Medicine, in contrast to the trend toward synthesis mentioned above, moves toward extreme specialization. A revolutionary advance in detailed knowledge pours from about 900 medical journals in the U.S. and many others in the rest of the world. Experts have divided between themselves the functions of body and mind into about 36 specialties. The general practitioner, utterly unable to compete with their instrumentation, tests, and concentrated experience, is dying out. Still, his integrating common sense is sorely needed.

The solution to this dilemma was found in group practice, pioneered and brought to awe-inspiring perfection by the Doctors Mayo and their clinic. The skyscrapers of the Mayo Clinic, set on the prairie of Minnesota, house hundreds of medical doctors representing all specialties, supported by an army of about 1500 assistants, technicians, nurses, etc. Every day about 500 new patients enter this "Diagnostic Center of the Medical World" and leave a few days later with the most exhaustive analysis of their state of health that modern medicine can provide. The findings, integrated under the individual care of a doctor of internal medicine, recommend a course of remedial action. Operations and other treatment are performed by the specialists of the Center in surrounding hospitals, if the patient so desires.

This pooling of knowledge and resources could not be accomplished if the doctors felt geared to a diagnostic supermachine designed to grind out routine information for private profit. It works because they live as a free association of colleagues, continuously learning from each other and expanding their individual competence by drawing on the tools and methods of the whole clinic and on its immense store of accumulated experience. It works because bureaucracy and lost motion have been cut to a minimum by effective organization and mechanization of tests, thus leaving time for mutual consultation, lectures, and thinking. It works because the doctors are "equal among equals," handle the affairs of the clinic themselves by a "committee of

THE PHOTOGRAPH on the preceding page (by Bob Lyon) shows a mobile by Al Duca hanging beneath the dome at the Massachusetts Avenue entrance to M.I.T. during a recent exhibit entitled "The Age of Materials."

eleven" elected for one four-year term, and turn over the profit of their joint enterprise to a foundation dedicated to the further advancement of medicine.

Here, obviously, is a successful prototype organization for the effective collaboration of experts. It has averted the danger of internal strife by selecting its members according to competence and character. Objectivity and openness ban political plotting; respect for the opinion of others, tact, and helpfulness are expected; unbridled ambition, egotism, and arrogance disqualify. Substitute for the specialist doctor a professor with his students, creatively engaged in his special research program in the field of materials, and you have the spirit and first outlines of an organization for our Center.

Input, Output, and Converter

Let us switch standpoints to place the problem in a different perspective. An engineer, when inventing a device, strives to develop a converter that transforms a prescribed input into a desired output. Viewed in these terms, the situation at the Mayo Clinic seems straightforward: the input is patients with unknown ailments, entering the front door; the output is patients, analyzed and marked for treatment, leaving by the back door; the converter is an intricate kind of machinery measuring the patient's status quo and reactions, staffed by expert analysts who evaluate the evidence. There is, in addition, a hidden feed-back loop leading from patients during their later treatment back to the experts and into a case-memory unit. This stored experience is converted internally into additional information about the recognition of diseases, their trends and treatment.

The Center for Materials Science and Technology envisioned at M.I.T. is more complex to picture, since its tasks are more involved. It is to be an institute for graduate and post-doctoral studies ranging in scope from abstract theory to fully engineered prototype devices. It will be concerned with materials: their structure, composition, properties, and applications from atoms and molecules to gases, liquids, solids and their interfaces, from insulators to electrolytes, semiconductors and metals. It should be a center for education and information, for pioneering and advice, for trouble shooting and long-range planning. The Mayo Clinic would correspond to an Institute for Materials Analysis only. Our center, in medical analogy, will have the much greater task of rebuilding man and making him fit to live in his surroundings; it anticipates —on the level of nonliving matter—the "medicine of the future."

Arthur Linz, '46, growing crystals by means of flame fusion.

How are we to embody this entity in a "Center for Materials Science and Technology," which seeks insight by "Molecular Science" and proficiency by "Molecular Engineering" for the construction of materials, properties, and devices from the atoms of the Periodic System? How can we strengthen the university concept of free scholars, while simultaneously drawing on the united strength of their knowledge for the common weal, since knowledge—like noblesse—obliges? To perceive the actual organization more clearly, let us turn once more to the analogue machine with its input, output, and converter.

The input is people, ranging all the way from students working on bachelor's, master's or doctor's theses to scientists and engineers accepted as post-doctoral fellows or returning from years of activity in laboratories of Government or Industry for a refresher period at the university. Materials and ideas are taken in as needed but, to a major extent, the Center should generate original materials and ideas. Requests will range the gamut from simple information on characteristics to reports on the status of knowledge in certain areas and, finally, to integrated research programs, e.g., on materials for space travel, or the proper allocation of a country's resources.

The output obviously is more highly educated people, better materials, new ideas and devices, deeper knowledge, and comprehensive information. But what is the miraculous converter that transforms input into such a varied output by voluntary action?

Center Organization

If the entity "professor(s) with students, supporting staff and instrumentation"—experts of a special field engaged in imaginative research—is named a "Laboratory," the Center represents a "federation of mutually supporting laboratories."

To assure a maximum amount of freedom, unnecessary centralization should be avoided; i.e., each laboratory should retain all of the functions it can discharge effectively. It can best handle its own requirements as to the hiring of man power, purchasing of equipment, and carrying on of research. Close personal contact between experimental projects and supporting machine shops has proven extremely valuable and could be maintained by letting laboratories or groups own and operate individual shops for their normal work.

The true driving force of the Center should be its interdepartmental faculty, selected for expert knowl-

Professors Harold E. Edgerton, '27, and Perry A. Miles, with a newly developed, efficient light source known as a laser.

edge and originality in decisive areas of materials and device research, and for compatibility. For teaching purposes, the professors would be members of various departments; in research activities, their loyalty should belong to the Center. The faculty meetings in various Centers, concerned with issues of vital importance to their members, would restore to the university the fire of spirited debate and common action that is now lost through the size of our institutions.

The executive branch of the Center could be a "Coordinating Division," headed by a "Committee of Three," elected for a four-year term. These three "directors" should be experts from various fields (e.g., a theoretical scientist, an experimental scientist, and an engineer) still actively engaged in research. Their combined knowledge would make them respected and helpful discussion partners for their colleagues. Pioneering research is a lonely task, and advice and encouragement at the right time can move mountains.

The Center should receive one or several large Government contracts to assure its main support on a long-range basis for effective planning. Smaller contracts for special needs of individual laboratories might be procured when indicated. The individual laboratories would draw annual budgets from the Center, fixed on an equitable basis according to needs and resources. The figures established in discussions between the director of each laboratory and the directors of the Center might be presented later in a faculty meeting of the Center, and there appealed and defended.

The "Coordinating Division" under its directors would have some obvious tasks: to create and maintain facilities and services required by the Center; to formulate and implement Center policies, subject to approval by the faculty; and to represent the Center to the M.I.T. administration at large and to outside agencies.

There are also some obvious facilities the Center must have: shops with special machinery and skills complementing those of the individual laboratories; a Library, Information, and Publication Center concerned with the whole field of materials and their applications (to place the literature of the whole world at our fingertips, publish the quantitative information accumulating by Center research as "M.I.T. Tables on Materials," give rapid information to any justified request, and edit Center reports and publications); a Budget and Purchasing Office controlling expenses, and disbursing the funds of the Coordinating Division.

Policies and Procedures

In contrast to the Mayo Clinic, input and output cannot be traced at this kind of Center to one front door and one back door. Here we have a living organism of cells, the laboratories—maybe 25 to 50 in number—all with entrances and exits in addition to the main ones of the Coordinating Division. Thus much of the Center's strength cannot be organized from the outside but will have to grow by spontaneous co-operation in a favorable climate. Certain needs, on the other hand, must be met by inventive organization.

Materials are required by all experimental laboratories, grown as single crystals or prepared as polycrystalline specimens, produced as gases, liquids, polymers, or glasses, shaped into prescribed samples and properly synthesized and analyzed. For a real understanding, many of these samples must be measured exhaustively. Data will be required on structure and microcomposition, on imperfections and phase transitions, electric and magnetic response throughout the electric and optical range as functions of temperature and pressure; on mechanical response, transducer and

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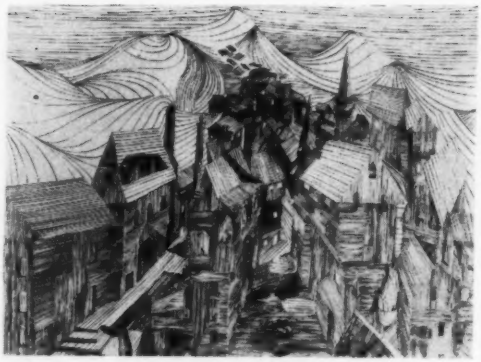

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Education in Art at M.I.T.

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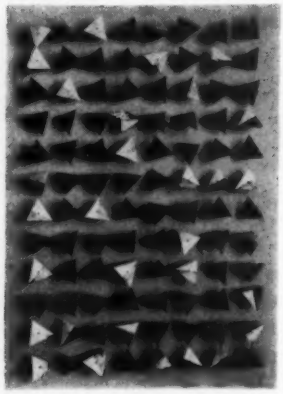

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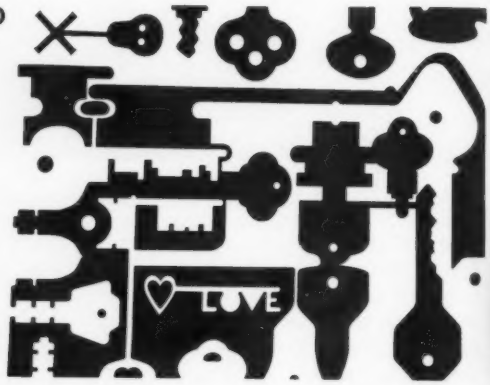


BY

ROBERT O. PREUSSER

Assistant Professor of Visual Design

PARTICIPATION in the visual arts is giving a new dimension to education at M.I.T. Contrary to the myth that Art and Science do not mix, students are freely electing studio courses and performing creatively. This recent development is the Institute's response to the urgent need of overcoming visual "illiteracy" in an age increasingly dependent upon perceptual awareness.

The visual arts program, a tenth field in the humanities and social studies electives from which each student selects an area of concentration in his junior and senior years, is attracting students from more than half the departments in the Institute. By combining history and criticism with drawing and painting, the program affords an opportunity for students to gain an understanding of art and develop confidence in visual expression.

As an innovation in general education for scientists and engineers, the study of art with its capacity to transform concept into immediate experience, and make possible instantaneous total projection of thought and feeling, transcends education in the conventional sense. The artist's method of working intuitively and empirically to achieve qualitative values is a unique experience for students oriented toward quantitative concepts arrived at by formula. M.I.T. students' successful studio performance evokes no less surprise than that such an opportunity exists in a scientific and technological school. There is impressive evidence that visual sensitivity and ability to create visual form can no longer be considered the exclusive domain of the liberal arts colleges.

The role of the visual arts in modern education has been of increasing concern to colleges and universities in recent years. No exception to this trend, M.I.T. was among the first to give it serious consideration. An investigation, resulting in recommendations for the existing program, began in 1952 when the School of Humanities (supported by the Carnegie Corporation) appointed a committee for the study of the Visual Arts at M.I.T. Initiated by John E. Burchard, '23, Dean of the School of Humanities and Social Science, this committee consisted of John Coolidge, Director of the Fogg Museum at Harvard University; Robert Iglehart, Chairman of the Department of Art at the University of Michigan; Bartlett H. Hayes, Jr., Director of the Addison Gallery of American Art at the Phillips Academy, Andover; Charles H. Sawyer, Professor of Art

The photos above are of (A) surface variation with lines, by Edward Agro, Course VIII; (B) paper relief sculpture, by Robert Fisher, XXI-A; (C) mobile relief with magnetized triangles, by John Karl, VIII; and (D) figure ground reversal with positive or negative imagery, by Richard Lyons, II; and the one on the next page is an experimental drawing made with a comb and ink by William Black, VI-B.

at the University of Michigan; and James J. Sweeney, then Director of the Solomon R. Guggenheim Museum in New York.

In the committee's own words, its task was "to determine the nature of a Visual Arts program which might contribute not only to the efficiency of the technical mind but also to its scope by providing the student with an insight into nontechnical values which he might not otherwise attain." The findings emphasized that neglect of visual education had resulted in a discrepancy between the average freshman's ability to think and to see. "The goal of the ideal program is to develop the capacity of the technician to undertake responsibility for the forms that his technical training creates," the committee reported. "The quality of these forms, as of his own spiritual insight, ultimately affects the social atmosphere and climate of thought of his entire world."

Within the framework of this report, the Department of Architecture organized the Visual Arts program in 1957. By providing courses in the visual arts for the Humanities Department, the Architecture Department has extended its teaching to include the general education of students at large in addition to its professional courses. Consistent with the undergraduate program in humanities and social studies, Field Ten-Visual Arts requires three semesters for credit as a concentration. Verbal courses include *Introduction to Art and Architecture, Modern Art and Architecture,* and *Architecture of Cities*. Studio courses deal with *Visual Design Problems* and *Visual Design Projects*. Any combination of these is permissible provided one studio course is taken.

In organizing the program the studio was considered as essential to the study of art as the laboratory is to the study of science. Just as participation without history and criticism fails to reveal the intellectual and historical significance of art, the verbal approach without studio experience neglects the potentiality of human creativeness and often fails to develop adequately the visual sensitivity necessary for response to visual problems of our day. It was felt that this point of view was particularly relevant for M.I.T. students, and that theory without practice would limit art's unique contribution to liberal education of the specialist.

Traditionally associated with the training of professional artists, the studio as a tool in general education is an experiment which requires that a distinction be made between the vocational approach to Art and one concerned with liberal learning. In making this distinction it became necessary not only to direct studio activities in such a way as to make them meaningful to students with no previous experience (and no intention of becoming artists) but also to design a course that would challenge students pursuing a wide range of professions. The creative process as

(Concluded on page 39)

Books

SCIENCE AND GOVERNMENT, by C. P. Snow; Harvard University Press ($2.50). *Reviewed by V. A. Fulmer, '53, Executive Assistant to the Chairman of the M.I.T. Corporation.*

THIS provocative essay is a case study of the role of scientists in the governmental decision-making process. It points up a number of challenges certain to become increasingly important in our national life.

"One of the most bizarre features of any advanced industrial society in our time," Sir Charles writes, "is that the cardinal choices have to be made by a handful of men: in secret; and, at least in legal form, by men who cannot have a firsthand knowledge of what those choices depend on or what their results may be." In the lexicon of political science, this book is an analysis of "closed" political systems . . . the machinery by which scientists are asked to give secret advice on the crucial questions of our times.

The plot concerns two men and two cloak-and-dagger choices: Sir Henry Tizard and F. A. Lindemann, who engaged in a now famous controversy over the development of radar as Britain's principal air-defense system and, later, over strategic bombing against Germany in World War II.

M.I.T. Alumni will have a special reason for reading this lucid little book, quite apart from its timely subject matter. C. P. Snow's chronology of events leading up to the British decision to send Sir Henry Tizard to the United States with British radar secrets in September of 1940 is an important, heretofore unpublished chapter in the history of the wartime Radiation Laboratory at M.I.T. Roughly half of this book is given over to the pulling and hauling which preceded Tizard's arrival in this country.

C. P. Snow's conclusion is that advanced societies desperately need more scientists in government, although the reader will probably be surprised at the reason *why*. He points with deep concern to the risks that advanced societies run in their ultimate dependence upon the fallible judgments of a few knowledgeable individuals. He shudders, for example, at the thought of what might have happened to England if Sir Henry Tizard had allowed radar development to become sidetracked in favor of other schemes for air defense. He is even more apprehensive about the buffeting of great national decisions by the hot winds of personal relations between scientists. If personalities carry a heavy weight in "open" political systems, then they are at a classical extreme in the dynamics of "closed" politics. Decisions based upon scientific choices almost always involve this larger risk, Sir Charles maintains. The "euphoria of secrecy," imposed either because of military requirements or because of the natural difficulty of communication between the scientist and nonscientist, leaves most scientific decisions in the hands of dangerously few men.

The author's prescription for this poor state of scientific health in national governments is simple. It would be ideal, he observes, if we could insist upon wide scientific literacy among government administrators. But this is not really a practical solution in the foreseeable future. Failing this, advanced societies should:

1) Avoid at all cost a single scientific overlord.

2) Avoid "gadgety" scientists in government. The closer a scientist is to some hardware development, the less likely he is to be objective about scientific choices which might involve his or someone else's gadgets . . . atomic bombs, antibiotics, and television sets included.

3) Enlarge the number of scientists involved in advising government.

But the crux of the matter, according to Sir Charles, is not how to protect society from science but how to use science to restore initiative in societies grown flabby with their own success, societies which have lost their sense of purpose. At one end of the spectrum of uses to which governments can apply science is the destruction of human life . . . at the other end stands the preservation of life. In both regions, C. P. Snow feels, there is no shortage of initiative. Men have always been able to think ingeniously about life-and-death matters affecting society.

It is in the great range of opportunities that lies between the two extremes of destruction and preservation of life that scientists should be employed in greater numbers. By temperament and tradition, scientists can bring speculative and imaginative influences, and above all, a sense of the future, into our political processes. Though he claims no special foresight for scientists as a group, Sir Charles argues that their disciplined sense of time (of science as an endless frontier, to use Dr. Bush's words) can revitalize our society in this great political middle ground. Scientists, more than any other single group, can help us to replace our existential order with one that is future-directed.

Sir Charles's book adds significantly to the scant literature available to the student of science and government. There can be no doubt that he has performed a service in putting so concisely what others have only hinted at with much less economy of words.

Engineers in this country, and perhaps in England, will regret the unfortunate blurring of the role of the engineer in the great wartime developments reported in this book. In the hands of a literary giant like Sir Charles, this fuzziness is a real hazard to improved pub-

(Continued on page 52)

Books the President Has Read

THREE of seven books which have influenced John F. Kennedy's approach to the presidency, according to The New York *Times* Sunday Magazine (March 12), were written by members of M.I.T.'s Faculty. These books are: *Turmoil and Tradition,* a study of the life and times of Henry L. Stimson, by Elting E. Morison; *The United States in the World Arena,* by W. W. Rostow; and *The Question of Government Spending,* by Francis M. Bator, '49. All three were published within the last year and widely reviewed.

Weather Satellites and Forecasts

The quality, scope, and imaginativeness of predictions will be improved as the wealth of data becoming available is analyzed

BY ARNOLD H. GLASER

WHEN the first meteorological satellite, Vanguard II, was launched into orbit to scan the clouds below it and telemeter the results back to ground stations, scientific pundits promptly took to the airwaves to proclaim the arrival of the meteorological millennium: henceforth accurate forecasts would be available many days and weeks in advance. Its orbital inclination of 33 degrees barely permitted the satellite to peek into the temperate zones, but this was overlooked. Also ignored was the experimental nature of the satellite; before it was launched (February 17, 1959), no one had a clear idea of what to expect, so no provision was made for rapid data processing or for worldwide dissemination of the results. Data processing is just now nearing completion. Understandably, there was no noticeable immediate effect on meteorological forecasting.

On April 1, 1960, TIROS I, a more sophisticated television satellite, was injected into an almost perfect circular orbit 450 miles high. Its 48-degree orbital inclination permitted its television cameras to scan the atmosphere nearly to the Arctic. Teams of trained satellite meteorologists were waiting at the ground stations, armed with rapid, flexible techniques for data processing. Pictures came flooding down from the satellite—marvelous pictures, far exceeding in information content the hopes of the most optimistic. Hastily organized communications networks carried the fresh meteorological data around the world. Once again the meteorological millennium was proclaimed.

The man in the street, however, saw no improvement in the accuracy or adventurousness of his daily forecasts. The reason, of course, was that TIROS I was also an experimental satellite, not intended for serious operational work. It was spin-stabilized to act like a gyroscope in space. Its camera, pointing downward only when one extension of the spin axis intersected the earth, took pictures when that part of the earth was sunlit. The earth's magnetic field, interacting with the fields produced by the satellite's electronic circuits, caused the spin axis to drift about in space, perversely causing TIROS I to spend much of its time looking downward in the Southern Hemisphere. Accordingly, when a forecast was to be made for New York, the probability was small that a recent picture had been taken in the area of interest, and even smaller that a sequence of picture coverages at 24-hour intervals was available to permit tracing the progress and development of storms and fronts.

But on the various parts of the earth to which TIROS pointed, new meteorological marvels were constantly found. Cyclones, anticyclones, fronts, hurricanes, and even occasional jet streams stood out in clear relief, and unexpected structural details were revealed for the first time. Entirely new meteorological phenomena appeared, then obligingly reappeared to confirm their reality and frequency.

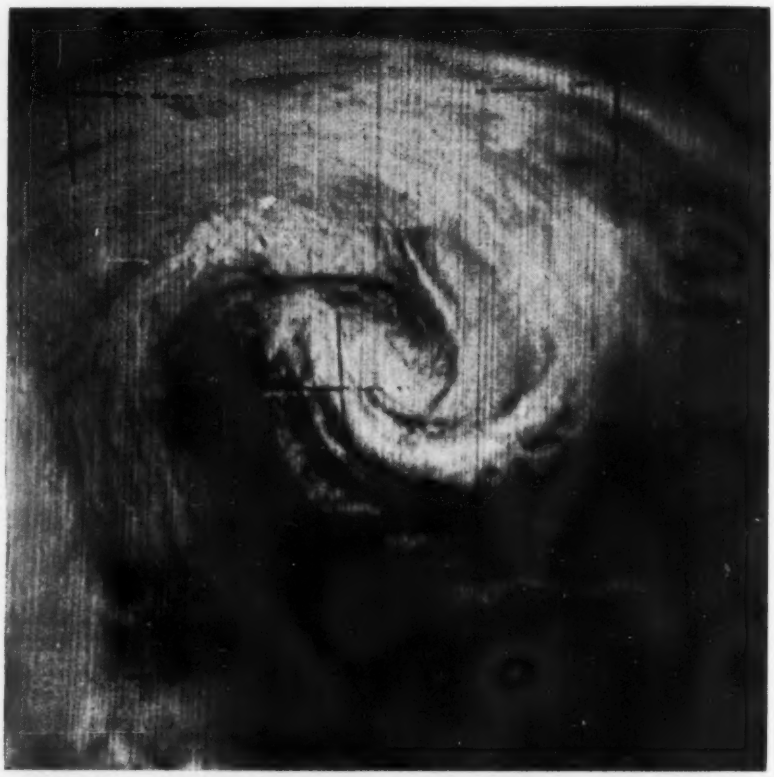
TIROS I expired at the ripe age of 78 days after collecting 22,952 pictures. Research meteorologists, appalled by the sheer bulk of data represented, have now made a small beginning on the task of combing through these pictures to correlate the cloud patterns with the features of conventional pressure-and-temperature weather maps. The material for many a master's thesis is contained on the TIROS I films.

TIROS II, fired on November 23, 1960, suffered an accident of unknown nature during launch that spoiled the resolution of its wide-angle camera. While its pictures will be of less utility for research purposes than those of TIROS I, it is being found that even pictures of reduced resolution are of considerable value for operational forecasting purposes.

In addition to its cameras, TIROS II carries a battery of radiation sensors, designed to scan the atmosphere in various wave-length bands from the visible through the far infrared. The output from these sensors will be of value in determining the heat budget of the earth and its atmosphere, and in isolating the factors that control it. Since the weather represents the action of a heat en-

ARNOLD H. GLASER, *'52 (at right) began his meteorological career with a revolution-punctuated tour of duty as an airline forecaster in Peru and Bolivia. He has since taught meteorology for the U.S. and Brazilian Air Forces and at Texas A. & M. College. He is now manager of the Geophysics Department of Allied Research Associates, Inc., of Boston. His group there has developed techniques of processing and utilizing data obtained from the TIROS meteorological satellites. Dr. Glaser deplores Boston's recent weather but has no practical solutions to offer for its amelioration.*

Signature clouds of a vigorous young cyclonic storm. The clockwise flow lines show it is from the Southern Hemisphere.



A mature cyclonic storm in the southern Indian Ocean. Clear (dark) wedge in foreground is characteristic at this stage.

gine running between the solar heating of the earth as boiler and the thermal (infrared) emission of the atmosphere as condenser, understanding of the heat budget is basic to understanding (and perhaps controlling) the weather. Each of the five scanning optical sensors makes about one million observations per day. Understandably, some time will pass before the data will have been even partially digested.

TIROS II is still operating at this writing. It is to be followed by TIROS III, and later by TIROS IV. These will be minor modifications of the same basic experimental satellite.

Next Year: NIMBUS

Scheduled for launch in 1962 is NIMBUS, an advanced experimental system featuring earth stabilization and a near-polar orbit.

This stabilization will permit its cameras always to point downwards, so that essentially complete coverage of the earth can be obtained once each 12 hours. Television coverage will be provided on the daylight sides of the orbits, while infrared scanning will permit cloud identification on the nighttime sides.

A special data-acquisition station is being established north of Fairbanks, Alaska, where it will be in a position to receive satellite-stored television and infrared information from nearly all orbits. A special high-capacity communications link will speed the pictures and other atmospheric data to weather centers in the continental United States. Future models of NIMBUS may include weather radars and detectors of "sferics," radio frequency emanations from thunderstorms and other disturbances.

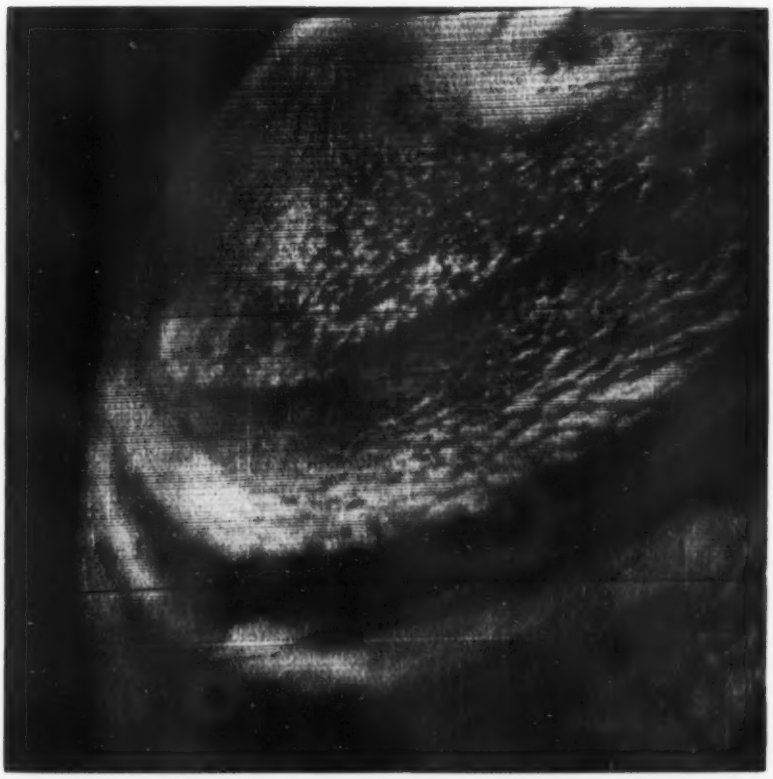
Even the advanced features of NIMBUS will not meet all the requirements of a satellite suitable for taking observations for operational forecasting purposes. One difficulty will be the 24-hour interval between similar pictures of the same area. While such an interval is suitable for general forecasts, particularly in "under-observed" areas, it provides too coarse a time resolution for the detailed weather forecasting we have learned to expect.

An obvious solution to this problem is to increase the number of satellites functional at any time. But the cost of launching a 650-pound satel-

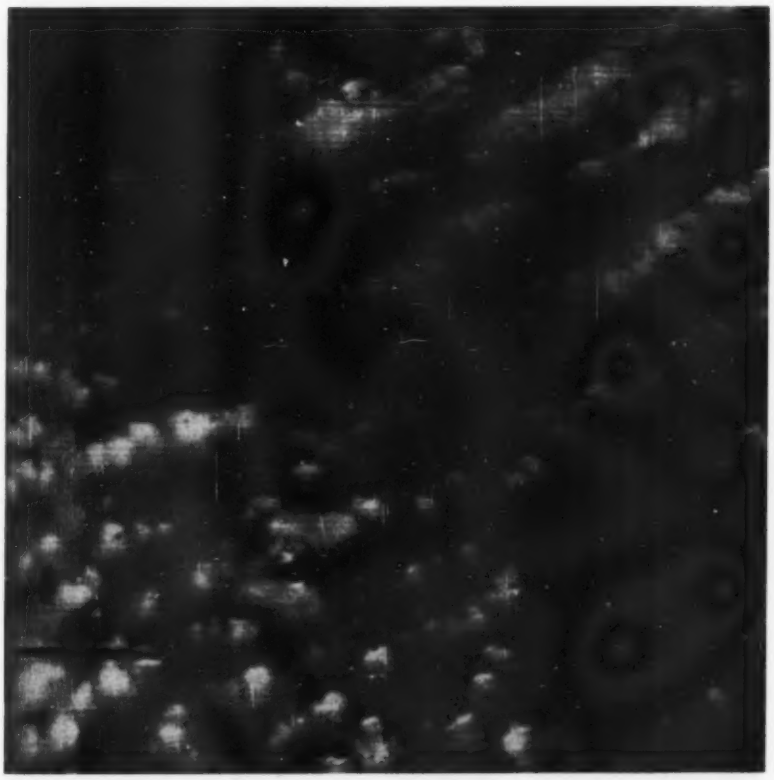
lite such as NIMBUS and the attendant problems of reliability, associated with both the electronics and the stabilization mechanisms, tend to discourage the operational use of a number of these satellites. If it were possible to assure evenly spaced orbits, six satellites might give excellent time and space coverage. Because of the random spacing that the satellites are likely to achieve after some time in orbit, however, a more realistic estimate of the number of satellites required would be nine or ten.

The AEROS satellite project represents an attempt by NASA to remedy this situation. AEROS would be a stabilized satellite moving in a 22,000-mile equatorial orbit in the same direction that the earth turns. At that distance, the orbital period would be 24 hours, so the satellite would appear to hover motionless over a point on the equator. From its great height, the satellite could constantly observe about one-third of the earth. Three such satellites could maintain surveillance over the entire earth with the exception of the polar caps. If some orbital inclination were present, the satellite would describe an apparent figure 8 with respect to some point on the equator, thus permitting surveillance of the polar caps. It can well be appreciated that AEROS represents a degree of sophistication that has not yet been achieved in our satellite construction. In order to be economically feasible, the AEROS satellite must have a long life, probably measured in years. With the necessary complication represented by the stabilization, the extremely high quality optics, and the long distance telemetry, such reliability could be achieved at the present state of the art only by the use of heavy and redundant components. If the same satellites were to be used as communications relay stations, however, the AEROS satellites might soon become economically feasible.

An alternate approach to the problem of achieving general coverage would be to use large numbers of low-flying satellites of as simple design as possible. It would appear feasible to make satellites which would require no stabilization at all beyond that provided by the slight torque exerted by the gravitational gradient on an unsymmetrical body. Picture taking would be performed



Broad bands of clouds, mainly cumulus and stratocumulus, on a weakening cyclone's outer fringe in the eastern Pacific.



A narrow angle camera shot over Saudi Arabia of rows of cumulus clouds. Individual clouds are about five miles in diameter.

over a field of view somewhat greater than 180 degrees, so the full horizon would be available for ascertaining the orientation of the satellite even when it was librating (rocking) because of gravitational perturbations. These satellites could be solar powered in the manner of TIROS; hopefully, reduced power consumption would permit reduction in the weight of the power supply components.

No provision would be made in this system for the storage of data on board the satellite. The simplest mode of transmission of pictures to the ground involves interrogation of the satellite by a ground station beneath it. This could cause it to take a single picture, or possibly a sequence of pictures, to be directly televised to the same ground station. In this fashion, a ground station could obtain a detailed view of the clouds in the atmosphere for a distance of 1,000 or more miles around it, which is ample coverage for short-range forecasting. Assembly of reports from a number of such ground stations could give very nearly complete coverage of the globe.

The frequency at which such observations could be made would be determined by the number of satellites in orbit. Because of the low orbit and cheap construction, 30 or so satellites could be in orbit simultaneously; failure of one or a few would not be catastrophic. A central data processor would have to keep track of the individual satellites, however, so that each ground station would know when to expect a satellite in its area for interrogation.

A more complex system of weather satellite communications would be possible with the network of low-flying active communications relay satellites that has been projected. In this case satellite interrogation could occur from a central station, the interrogation signal being relayed through the satellite communication network to the vicinity of the meteorological satellite assigned to take an observation. The transmission of its televised observation, slowed down to fit the capacity of the available communication channel, would return over the same route as the interrogation signal. Such a system would permit complete flexibility of operation, since irregular but frequent reports could be obtained from the entire earth and be available at one or a number of central stations.

Let us assume now that the mechanical and electronic problems of establishing full and frequent meteorological satellite coverage of the earth have been solved. What, then, may we expect from the forecasters? It may readily be predicted that, in general, forecasts will be improved. The degree of improvement to be expected, however, is still open to question.

Since the TIROS satellites survey the same region at best once each 24 hours, attention has been focused largely on forecasts of that period. For these short-range forecasts, the value of the satellite meteorological observer is almost self-obvious. The pictures show graphically the cyclones, fronts, and other major meteorological features of consequence in forecasting. They are shown so clearly that a mosaic of TIROS pictures has been called a "self-analyzed weather map."

For forecasts for periods shorter than 24 hours, the outlook is even more encouraging. The TIROS pictures present structural details of meteorological features that were never before available to the forecaster. In general, the lifetime of a structural element of the atmospheric circulation (a "system") is proportional to its size. The conventional meteorological network has been far too coarse to define details of size much smaller than major cyclonic elements or entire frontal systems. The weather radar, on the other hand, has proven itself of value only in precipitation forecasts of an hour or two at best. The meteorological satellite, then, appears to provide the density of data coverage needed to supply detailed forecasts for periods of interest to most of us —one day down to a few hours.

The utility of the meteorological satellite in longer range forecasting is by no means as clear. The restricted coverage of the TIROS satellites has made it difficult to assess the feasibility of the interpretation of giant-scale cloud systems (cyclone "families") in terms of the long-range forecast.

Once we consider the problems of forecasting for periods greater than five days or so, we must abandon simple extrapolation of existing systems or groups of systems and consider the basic energetics of the atmosphere. Here the infrared observations of the meteorological satellite may prove of value. Techniques for using these observations for such purposes are being explored, but it is far too early to judge whether our grasp of the workings of the atmospheric heat engine is sufficient for such long-range forecasts.

As for forecasts in excess of a month or so, it would appear that we must depend upon the fascinating discoveries being made by those who are studying the relation between manifestations on the sun and the weather on earth. It may well be that special sensors on board the meteorological satellites to measure the behavior of the far ultraviolet and x-ray emission of the sun may make such far-extended forecasts possible.

After such a cautiously optimistic evaluation of the potential of the meteorological satellite the question may well arise, "Is it worth it?" But how does one evaluate man's increasing knowledge of, and control of, his environment? The economic value of accurate forecasting has been so well established that no one questions the continuous expenditure for our excellent network of conventional observations, both on the surface and in the upper atmosphere. By the use of this network, the U.S. Weather Bureau has achieved a level of proficiency of forecasting usually described pessimistically as "85 per cent accurate." It is quite impossible to estimate the value of even a small increase in that accuracy. Any substantial increase could bring enormous economic benefits.

Even if it should be found that the complex network of satellites and communications required for a full operational meteorological satellite system is not economically feasible for some time to come, we have collected a tremendous amount of new information already about the nature of the atmosphere, its storms and its clouds—and this flow of information is continuing. The new knowledge gained has already started to make itself felt in forecasting. Soon we may expect to see the quality, the scope, and the imaginativeness of weather forecasting improved to the point where the investment we have made will seem amply repaid.

Institute Yesteryears

25 Years Ago . . .

IT WAS publicized in The Review for May, 1936, that "the entrance requirements of the Institute have been revised and the new regulations, which permit greater flexibility in the choice of subjects and require fewer examinations, will become effective next autumn. The changes affect particularly those students who cannot qualify under the plan which permits students in the highest fifth of their class to enter Technology without examination. . . .

"Under the new entrance regulations, high- and preparatory-school students will be able to follow a more general program of preparation for their later work in science or engineering. In addition to a thorough preparation in English, which is considered a subject of fundamental importance, it is also necessary to be prepared soundly in physics and mathematics, on which much of the first year's work at Technology is based. The electives which may be offered include languages; social, biological, or physical sciences; mathematics, mechanic arts, mechanical drawing, commercial studies, fine arts, drama, or music."

¶ Kudos evidenced by medals came to five Alumni, namely: to *Frank B. Jewett, '03,* the Franklin Gold of the Franklin Institute . . . to *Arthur C. Willard, '04,* the F. Paul Anderson of the American Society of Heating and Ventilating Engineers . . . to *Charles A. Kraus, '08,* the Theodore William Richards of the Northeastern Section, American Chemical Society . . . to *Alfred V. de Forest, '11,* the Edward Longstreth of the Franklin Institute . . . and to *Vannevar Bush, '16,* the Lamme of the American Institute of Electrical Engineers.

50 Years Ago . . .

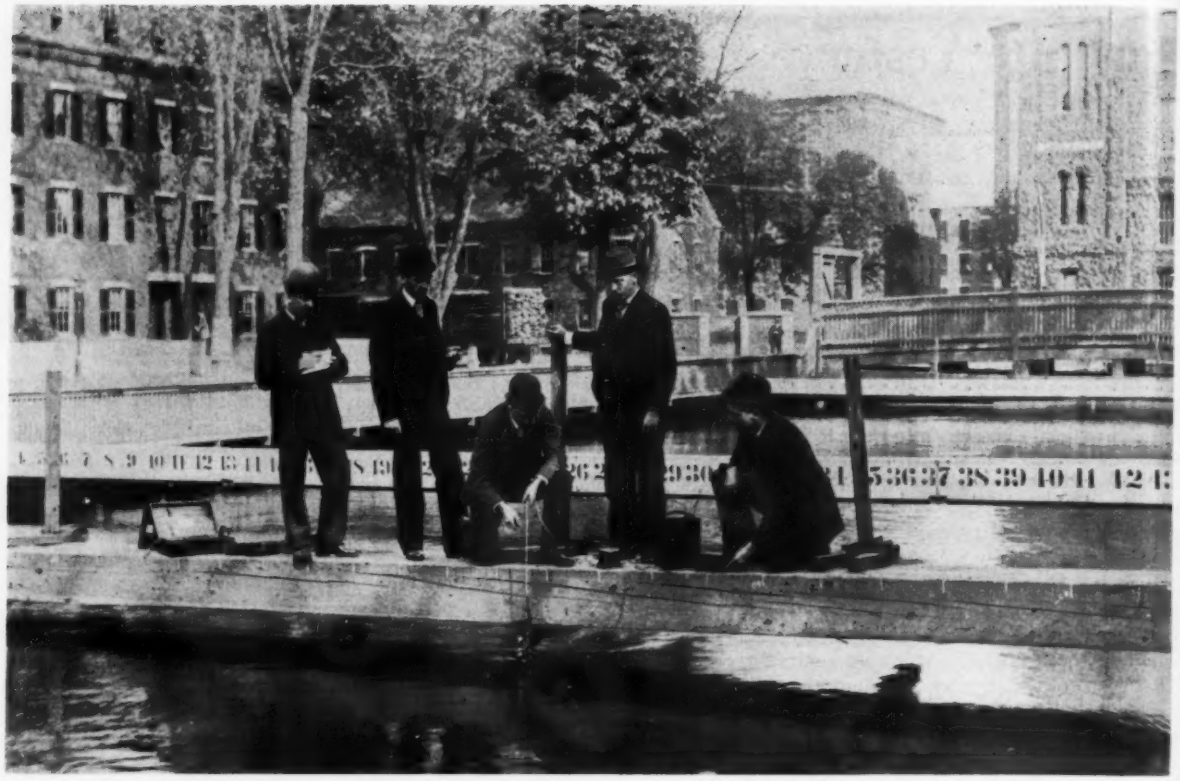
THE REVIEW proclaimed: "The wonderful unfolding of the Institute of Technology which has been going on for the past two or three years reached a climax [during May, 1911] when within a period of a week, announcement of new sources of income were made which roughly aggregate $2,500,000.

"The signing of the bill by Governor Foss, granting the Institute $100,000 a year for 10 years is the most important of these developments because this money will provide for the running expenses of the Institute and will allow the gifts of alumni to be devoted to buildings and other specific purposes . . .*

"The next important announcement was a gift of $500,000 from Coleman du Pont, '84, a Life Member of the Corporation. This money is to be used in buying land for a new site . . . One of the stipulations is that

* Altogether, up to 1921, the Institute received from the Commonwealth about $1,600,000, in addition to the original grant of land; but, in that year, a change in the Constitution made all further gifts to privately endowed institutions impossible.

Professor William T. Sedgwick lecturing in a 19th Century predecessor of the Institute's modern biology laboratories.



Photos from a Centennial Exhibit at the M.I.T. Faculty Club

Institute students in the 1800's made Ellis meter measurements at Lowell. The instrument measured the flow of water.

a certain amount of land is to be secured for a site in a locality approved by him, which must be as convenient as possible to Copley Square . . .

"The will of Mrs. William Barton Rogers provides that the residue of her estate after paying certain legacies to relatives, shall revert to the Institute. The newspapers state that this amount will approximate $500,000.

"The Institute will also receive from the estate of the late Francis B. Greene the sum of about $600,000, from a trust fund created five years ago and which was only recently made known to Institute officials. The income from this fund is to be used entirely for scholarships . . ."

75 Years Ago . . .

"THE ALL-ABSORBING topic at present in the local affairs of the city is the horse-railway problem," commented the editor of *The Tech*. "The daily papers contain many accounts of the wrongs and nuisances committed by these corporations.

"Our own little grievance, at the Institute, is the failure to always induce a car to stop when signalled. The drivers, acting, we suppose, upon the supposition that everybody here is a young athlete, and perfectly able to jump on the car in motion, drive by our building at full speed.

"The trouble comes when, on a rainy night, with a drawing board under one arm and a bag and umbrella under the other, a man is expected to catch a car on the fly.

"We happened to notice, one evening some months ago, a couple of fellows descend the steps of Rogers and invite, in a perfectly distinct manner, a passing car to stop. The conductor declined the invitation, and stood in the doorway of the car with a very expressive grin on his face, evidently enjoying the race, for the two gave chase. The latter won, but not until the car had reached Arlington Street. This conductor was probably a trusted and honored servant of the road by which he was employed, for he was seen on the street, a few weeks after, promoted to the dignity of a car-starter."

¶ In an adjoining column appeared the following: "Now doth the weary and over-worked senior nose around in search of a subject for a thesis that will insure him a degree with the minimum amount of work."

¶ The annual battalion prize-drill was held in the large hall of the Charitable Mechanics Building on the afternoon of May 15, 1886. According to *The Tech*, "an enormous crowd of spectators, including officers of other school battalions, and many ladies, was present.

"The line was formed promptly at 2 o'clock for a half-hour's battalion drill; and this was followed by the company drill for the prize flags, in which each company was allowed 15 minutes. The sabre squad under Major Fiske next had the floor, and gave a good exhibition. Then came guard mounting, with Captain French as the officer of the day. . . .

"After the dress parade, in which the drum corps were quite noticeable, President Walker awarded the prizes. . . ."

BUSINESS IN MOTION

To our Colleagues in American Business . . .

The rapid development of the modern submersible water pump has resulted in the development of new applications for old metals.

Recently one of Revere's Technical Advisors was called in by a prominent manufacturer of this type pump for consultation regarding the diffuser casing which is a working part located in the interior of their pump used in deep and shallow wells. It was made of a ferrous metal and, while it functioned satisfactorily as a part, it proved difficult to fabricate. In addition, tool life was alarmingly short. After studying the problem in cooperation with the manufacturer's engineers, and consulting with the Revere Mills, Revere cartridge brass strip of a certain temper was recommended.

Samples were submitted, and after extensive tests approved for the part. The customer has found that not only does the diffuser casing, made of Revere Brass, perform well in the pump, but it also has superior drawing properties, is more easily worked, and tool life has been substantially increased.

This meticulous attention to "fitting the metal to the job" also resulted in this manufacturer's specifying Revere seamless leaded brass tubing for the upper body shell of its submersible pumps. Here the application called for extremely close straightness and roundness control which meant special attention to detail on the part of the Revere Mills.

You have just read of two more examples of the vital importance of selecting the metal that is not only satisfactory from a functional standpoint but one that is equally satisfactory from a production standpoint. For, what may be saved on one hand can very well be lost on the other, if the metal is not properly balanced to fit the conditions met, both in use and in fabrication.

It is only by taking your supplier into your confidence that you can ultimately produce the best possible product at the least possible cost.

REVERE COPPER AND BRASS INCORPORATED

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Executive Offices: **230 Park Avenue, New York 17, N. Y.**

A University's Proper Heritage

(Concluded from page 25)

converter effects, etc. Any one of the needed techniques will be an essential research tool in one or the other of the laboratories and there practiced by expert hands. An individual laboratory can only be equipped for a few types of tests; hence, much research refers to ill-described samples and its value remains in doubt. Nowadays, nearly all special materials —developed after years of struggle—are prematurely discarded before yielding the final information that would obviate reinvestigation.

The Coordinating Division, therefore, will have to organize a co-operative effort for making and measuring materials to perfection. It must be possible to grow crystals, cast metals, prepare ceramics, glasses, and polymers in Center facilities attached to and supervised by the individual laboratories. It must be possible to send standardized samples from the laboratory of origin through a succession of test stations for a thorough check-up. This chain of production and test facilities, maintained by the Center but developed by and entrusted to individual laboratories, would simultaneously serve for the education of students in skills and methods required for their thesis research.

The Coordinating Division also will have to create and maintain a small staff of broadly trained scientists and engineers who—as crosslinking agents—transfer knowledge and give temporary help when individual laboratories encounter problems beyond their special experience. This staff would attract experts who are artists in making materials and devising new techniques; it would be a training station for mature scientists and engineers, seeking a more comprehensive view of large areas of materials and device research; and it would contain people concerned with new, imaginative methods of classifying, storing, and retrieving knowledge, thus making the Information Center a true source of advice and an indispensable guide of policy.

Co-operation must not become exploitation. Fifty per cent of a faculty member's time should be his own for research with his students. Shielded by these and other safeguards, a Center can rekindle and transfer the spirit of adventure, comradeship, and mutual enjoyment of discovery now nearly killed by competitive pressure. It can shelter laboratories yet unlabeled, where people dream about things to come. This is a university's proper heritage.

The Scientific Community's Size

AMERICAN scientists constitute "a very large, highly interactive and growing community with a self-conscious identity," Vernon L. Fladager, '60, found in a study cited in recent discussions at M.I.T. of science and public policy. This community, he reported, totals 2,284,000 now, and consists of about 260,000 scientists, 634,000 engineers, 250,000 medical doctors, 140,000 teachers, and a million others classified as technical personnel.

From New York Life's yearbook of successful insurance career men!

RONALD SCHECHTER—Gets his degree in "Success" through insurance career begun in college!

Ronald Schechter became a part-time New York Life Agent while still a sophomore in college. Two years later, after graduation, he joined the Company on a full-time basis. Ron has never had any regrets about his decision. At the close of his first full year, his efforts earned him a place in Nylic's "Star Club" of leading agents. He has qualified for the 1961 Million Dollar Round Table of the National Association of Life Underwriters.

Each succeeding year, Ron has earned even greater success. His past accomplishments are the result of his abilities. His promising future is limited only by his own talents and ambitions. If you, or someone you know, is interested in following a career like this, write for information.

RONALD M. SCHECHTER
New York Life Representative in the Northland-Detroit, Mich., General Office

Education: Wayne University, B.A., '56

Employment Record: Joined New York Life (full time) '56. Member, Star Club '56, '57, '58; Top Club '59-'60

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Men Whom the Years Touch Lightly

Now and then you meet a man who seems young and vigorous to a degree that belies his age. People who have known him for years are apt to say admiringly, "*How* does he do it?"

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United States Trust Company

of New York

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When this advertisement ran in February 1940, the Kerite generator leads had been operating 30 years. And they were still operating without failure when the turbo-alternators were dismantled in 1955 .. for a total of 45 years of perfect cable service.

BE GUIDED
by facts, not claims
by service records, not initial tests
by experience, not prophecy—
The 11,000 volt generator leads on these Turbo-Alternators of the 59th Street Power Station of the Interborough Rapid Transit Co., New York City, are all single conductor braided
KERITE CABLES
INSTALLED IN 1909, 1910, 1911
They have all given and are still giving continuous and satisfactory service.
THE KERITE INSULATED WIRE & CABLE COMPANY INC

These KERITE cables

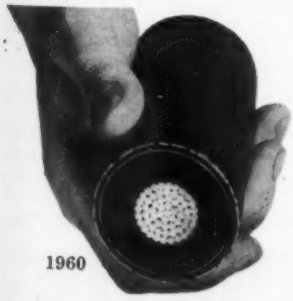
. . . were designed without any of the accurate methods now used to determine conductor size. They were overloaded throughout their lives, and although they were installed in brass pipes and operated at 11,000 volts, they were protected only with a non-conducting cotton braid.

1909

In 1946, one lead was removed, reeled, and shipped to the Kerite factory for investigation.

In spite of 36 years of thermal abuse, almost constant electrical discharge at its surface, and the physical handling involved in its removal and shipment, the minimum 60-cycle A.C. breakdown was above 90 KV with the average 10 KV higher.

Kerite engineers have pioneered improvements in almost every element of generator cable . . . *but the consistently high qualities and long life of the Kerite insulation remain the same.*



1960

THE KERITE CO.
30 Church St.
New York 7, N. Y.
Sales offices in principal cities.

Education in Art

(Concluded from page 27)

a method of learning is emphasized rather than the production of Art for its own sake. Dormant creative ability is released with the objective of stimulating visual perception and fostering the capacity to plan, organize, define, clarify, and integrate on many levels.

The course is organized in two parts, each representing a semester's work of eight hours a week, and problems are so presented as to differentiate between visual and verbal expression. In the beginning, students are led to produce work, despite their lack of "talent" or "skill," in which they feel a sense of accomplishment and through which they gain courage to learn by doing. Imagination is challenged to search for form in accidental effects—visual play which perhaps had its origin in primitive man. Exploitation of the accidental as a method of creating visual form is by no means new, its practice was advocated by Leonardo da Vinci when he became intrigued with the images in clouds and cracked plaster. Recognized as an element of modern art, such activity creates purpose. The results generate a degree of confidence that no amount of conscious effort by the inexperienced could produce.

There is a continuing effort to keep this spontaneous process alive in exercises in composition, visual patterning, space organization, color dynamics, balance, proportion, scale, etc. Studio procedure in the second term is individually directed, allowing the student to formulate and execute projects in a wide variety of media. Having gained the confidence to create visual form and assimilated the basic principles of design in the first term, the student is prepared to explore more complex problems of art. Some are primarily interested in painting and sculpting in traditional media. Most are encouraged, however, to explore the visual possibilities of new concepts, techniques, and materials.

It is this kind of experimentation, seldom found elsewhere, that M.I.T. students perform differently than students at other colleges. Less inclined to work in conventional media, they frequently relate visual problems to concepts, techniques, and materials with which their specialized training has made them familiar. As a result, the projects executed are extremely varied, not only in media but in form and content as well. This approach is appropriate at M.I.T., because the specialist with a sensitivity to visual values can do much to reveal unprecedented dimensions in light, color, texture, and form inherent in modern science and technology, yet unfamiliar to the artist.

Through such activity, misconceptions about science as an enemy of art are dispelled and technology is recognized as a tool for aesthetically restructuring our visual environment. As one of the few disciplines in which inventiveness can be realized regardless of academic background, participation in this one gives students confidence to meet challenges in many fields of human activity. No less a factor, the students' sensitivity to visual values becomes an active reality, assuring intelligent responses to the numerous forms of visual communication bombarding us daily. Most important, the creative process as experienced in Art develops critical inner standards and contributes to a student's maturity and self-realization.

WTBS Extends Its Range

THE M.I.T. STUDENT radio station, WTBS, now has an educational license which permits it to broadcast to much of the Boston area on the 88.1 megacycle FM band. It also has new studios in the Walker Memorial Building, which were opened with appropriate ceremonies on the evening of April 10, the Institute's 100th birthday.

WTBS has provided closed-circuit broadcasting to dormitories and fraternities for more than 14 years, and its operators have long aspired to reach a wider audience. Its staff now includes more than 80 student announcers, engineers, and administrative workers, and they have procured modern facilities and technical equipment. In its daily broadcasts, the station will continue to present programs having wide appeal, including popular and classical music, jazz, folk music, news, interviews, and lectures.

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Trend of Affairs

(Continued from page 16)

Astronomy on the Blackboards

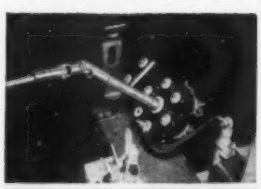
As VENUS and the earth circle the sun, they come within about 26,000,000 miles of each other at times, and these occasions—584 days apart—are likely to be chosen henceforth for efforts to peer through the clouds that hide the surface of Venus.

The value of space probes such as the Russians sent off toward Venus this spring depends largely on what they carry. Professor J. F. Reintjes and his associates at M.I.T. now are studying what might be accomplished by electromagnetic devices aboard spaceships.

Optical observations and celestial mechanics have revealed what little we know about Venus. Astronomers are uncertain how rapidly it rotates; they have been unable to determine the axis of that rotation, and they can only guess about its magnetic field, and whether there are continents or seas beneath its clouds.

More may be learned soon from radio and radar observations. Such observations soon will be possible from space vehicles as well as from the earth's surface. How much more can radar see from a vehicle passing close to Venus than from gigantic installations on the earth? Certainly a radar within 10 to 15,000 miles of Venus should reveal the gross features of the surface. What kind of radar system would be most effective aboard a space vehicle? How can its findings best be transmitted back to us? These and many related questions are on some of the Institute's blackboards now.

(Continued on page 42)



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Pad-mounted transformers for underground power distribution systems are built to last a lifetime. They require a minimum of maintenance. Settings are changed infrequently. But when a change is required, this switch must operate smoothly and surely. To insure a long, dependable life, without freeze-ups or rust-outs, the manufacturer equipped it with a Curtis C-646 1" O.D. Stainless Steel double universal joint.

This kind of dependability is the stock-in-trade of Curtis joints – size for size the strongest universal joints designed for industry. Selected materials, precision engineering, continuous testing, inspection and quality control at every stage of manufacture – these are some of the things that make Curtis joints your most dependable buy.

14 SIZES ALWAYS IN STOCK 3/8" to 4"

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ELLIOTT HEDGE AND EVERETT SMITH TALK ABOUT COMPANY BANKERS AT THE

NEW ENGLAND MERCHANTS NATIONAL BANK

—AND HOW THEY BUILD BUSINESSES WITH PERSONAL SERVICE

(*Mr. Hedge and Mr. Smith are Vice Presidents of the newly formed New England Merchants Bank*).

HEDGE: They did a beautiful job of building this one.

SMITH: They certainly did—and it's nice to think of it as *our* work, too. The New England Trust and The Merchants Bank were planning the financing even before our consolidation.

HEDGE: And it's just one of many jobs we've done together. Our two banks have shared loans for all kinds of companies.

SMITH: And we'll sharé *all* our loans, now that we're one bank. It should be easy. We always did work well together.

HEDGE: Why not? We've shared more than loans. We've always shared the same point of view. Our commercial officers at The New England worked closely with their customers—just like yours.

SMITH: It's more than close personal service, though. It's a—well, a *venturesome* attitude. Take electronics. The New England and The Merchants were in that field from the start.

HEDGE: Same thing with plastics, atomics, research. And now we can do even more.

SMITH: That's right. We have the increased capacity to take care of our customers . . . with more officers and more service than before.

HEDGE: Not just in Boston, but all over New England.

SMITH: You know, Elliott, New England's going to do a lot of growing. And New England Merchants is going to do a lot of *helping*.

NEW ENGLAND MERCHANTS NATIONAL BANK
28 State Street, Boston MEMBER F.D.I.C.

BARNSTEAD
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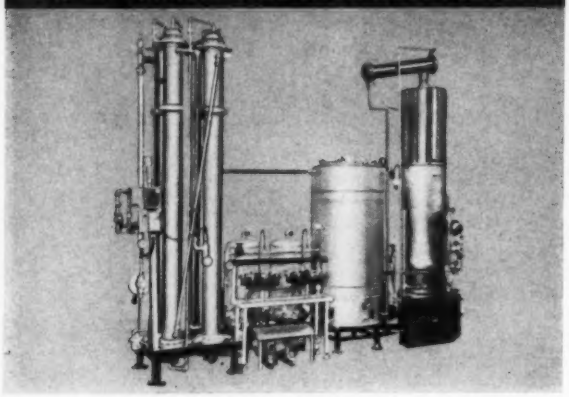
TO YOUR SPECIFICATIONS



PHILCO CORP'S Lansdale Tube Division uses this "Train" of Barnstead Pure Water equipment in various manufacturing cycles. Operating cost is low because the greater part of the process water is repurified and fed back into the system for re-use. This "Train" includes a Barnstead 20 GPH High Purity Still, 150 gallon, heated, ultra-violet equipped tank to prevent growth of bacteria, two BD-10 Holders with special high purity Supercartridges®, an MF® 200 Submicron Filter, and Heat Exchanger. Another example of Barnstead's versatility in lowering manufacturing costs.

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T. Hartwell, '28
N. A. Everett, '48
V. C. Smith, '48
S. Beran, '58

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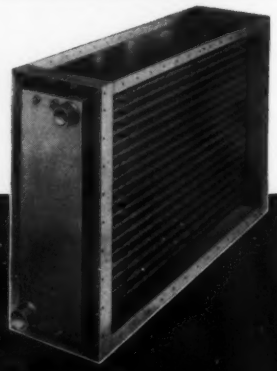

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Heat-Transfer Capacity
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LOW AIRWAY RESISTANCE

AEROFIN Smooth-Fin
Heat Exchangers

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Trend of Affairs

(Continued from page 40)

That Fourth State of Matter

SANBORN C. BROWN, '44, Associate Professor of Physics at M.I.T., told Sigma Xi lecture audiences throughout the Southeast this spring that discoveries in plasma physics are making our times truly exciting. Plasma physics is concerned with "the fourth state of matter," in which there is a neutral collection of ions and electrons, in constant motion, with characteristics that we have only recently begun to appreciate. Thus far, Professor Brown thinks, our knowledge of plasma physics has been "far outweighed" by attempts to exploit it.

Our planet, he has been pointing out, is whirling through space surrounded by a shell of plasma; interstellar space is full of it, and whole galaxies have told us of their existence by means of radio signals emitted from their plasma structure. Now we can study in the laboratory such tremendous sources of energy as the stars have, and possibly learn to control such reactions. This, he maintains, makes our times comparable to those when men first realized that the earth was but one of a galaxy of similar bodies, and saw that they could learn about stars by studying the earth.

We have urgent reasons, according to Professor Brown, to study the plasma state. The ionosphere and the Van Allen belts which surround our atmosphere form a plasma blanket between us and outer space. Furthermore, this blanket's density could be increased —with high-altitude hydrogen bombs, for example—to block out communication with satellites and prevent the detection of missiles by microwave signals. More understanding of basic physics is needed, too, to design practical thermonuclear devices.

Alumni Council Meeting

AT THEIR March meeting Alumni Council members heard briefly from President Stratton, learned that mailing of the 1961 Alumni Register will be completed by mid-May, received a final report on Centennial plans and an almost-final report on Alumni Day, and were told that more than 11,000 Alumni had contributed some $461,000 to the current Alumni Fund.

Speakers were Frederic W. Watriss, '41, Assistant Treasurer, and Vernon M. Ingram, Associate Professor of Biochemistry. Mr. Watriss discussed Technology Square, the new research and development center in which M.I.T. and Cabot, Cabot and Forbes are participating. Attractive space at rentals lower than Boston will appeal to organizations which value proximity to M.I.T. and Harvard, while the City of Cambridge will benefit greatly from the reclaiming of what was, in large part, a slum area. The ground is now cleared and building will be started this summer.

Dr. Ingram explained his work with hemoglobin cells, both normal and abnormal, in particular the so-called sickle cells. Anemia caused by these cells is especially prevalent in areas of Africa where malaria is endemic, resulting in infant mortality as high as 80 per cent.

Members and guests at the 351st Council meeting numbered 152. Association President Clarence L. A. Wynd, '27, presided.

(Concluded on page 44)

This is Cabot / #7 of a series

Thinking Man's Climate

Long since, Cabot has maintained its research headquarters in Cambridge's Research Row, in the heart of what has been called "the biggest, fastest-growing science-based complex in the U. S."

A heady, stimulating climate, this — spectacular for space-age accomplishments. Yet the atmosphere at Cabot is quietly different. Here, science is not concerned with electronics, or the myriad problems of putting a man into space.

Here, instead, science searches for ways to add extra mileage to automobile tires . . . to make white paints whiter . . . to make ceramics more beautiful . . . to make better and more economical raw materials for American industry.

Here, the victories of science are less spectacular — but, perhaps, no less important. For here, by laying the foundations for better, more useful, and more economical products, science serves industry, the consumer, and the economy — no small contribution to the preservation of a strong America.

For Industry, from Cabot:

CARBON BLACK — the world's most complete range . . . more than 50 different grades, each with a specific industrial use.

CAB-O-LITE® (Cabot wollastonite)—as a paint pigment, this versatile, uniform calcium silicate has more desirable properties than other extenders used singly or in combination. Excellent for all types of paint, and for all types of ceramics.

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CAB-O-SIL® — this unique airborne silica, in extremely small amounts, greatly improves an enormous variety of products. Remarkable for its unusual combination of properties, it's equally effective as a thixotropic, thickening, gelling, suspending, flatting, reinforcing, anticaking, and antislip agent. Used in plastics, lubricating oils, greases, paints, varnishes, lacquers, rubber, sulfur, insecticides, pharmaceuticals, cosmetics, and many other products.

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Trend of Affairs

(Concluded from page 42)

SCF Telephone Conference

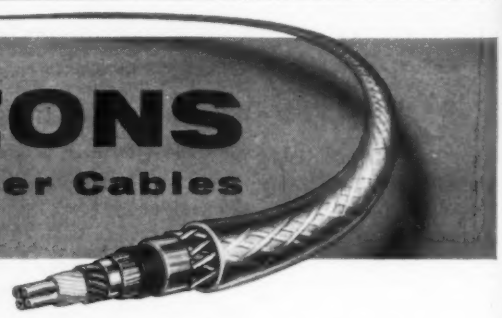
SECOND CENTURY FUND leaders in 16 areas took part in a private-line telephone conference on March 20, at which they reported gifts and pledges totaling $1,723,766. President Julius A. Stratton, '23, addressed the group from the Kresge Auditorium at M.I.T., and General Chairman John J. Wilson, '29, spoke to them from the Palace Hotel in San Francisco.

Philip H. Peters, '27, Chairman of the Area Organization, was the host, and the spokesmen for the participating areas were *William B. Bergen,* '37, Baltimore; *Robert C. Dean,* '26, Boston; *Philip L. Coleman,* '23, Chicago; *Charles H. Smith, Jr.,* '42, Cleveland; *John Lawrence,* '32, Dallas-Fort Worth; *Thomas F. Morrow,* '35, Detroit; *Frederick H. Dierks,* '12, Kansas City; *Charles H. Toll, Jr.,* '23, Los Angeles; *C. George Dandrow,* '22, New York City; *William J. Wiley,* '29, Philadelphia; *Howard J. Samuels,* '41, Rochester; *Gaynor H. Langsdorf,* '32, San Francisco; *Richard J. Donohoe,* '39, Washington, D. C.; *Haskell R. Gordon,* '38, Worcester; *Craig P. Hazelet,* '18, Louisville; and *Bissell Alderman,* '35, Springfield.

The largest sum reported from a single area was $427,067 from Boston, and the next largest $270,615 from New York. The Worcester area reported it had raised 126 per cent of its quota; Louisville had met 91 per cent of its quota, and Rochester was within 85.5 per cent of its quota at the time of these reports.

NEW HORIZONS

Armored Strength Member Cables



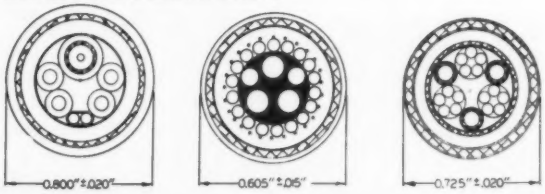
BIW has perfected an armor which not only protects the electrical cable but also serves as a supporting member for suspended equipment.

The armor consisted of woven strands of flat stainless steel or other material as determined by the physical and environmental requirements. Power cables, TV camera cables, control cables with audio circuits and electronic cables have been manufactured using this strong, protective armor. Typical applications include cables for towing underwater swimming devices, dropping and hoisting of detection and measuring equipment into water or oil wells and for other requirements where cables are reeled and unreeled under tensions.

Finished cables can be built with high strength-to-weight ratios using this armor so that the cable floats but still maintains a 3000 pound breaking strength. Since the strands are flat, this type of armor adds very little to the unarmored cable diameter. This armor virtually eliminates kinking and twisting thus relieving strain on the conductors as well as strengthening the cable.

These cables are designed and made to order to meet your specific problems. If your application requires a high strength electrical cable, or a high strength cable combined with flexibility and light weight, we would be pleased to discuss your problem and suggest a solution.

A few cross-sections of cables already designed and in use are shown below.



BOSTON INSULATED WIRE AND CABLE CO., BOSTON 25, MASS.

Frank Shull, III, (center) discusses a life insurance program for A. Richard Malkin and his wife Marjorie. Mr. Malkin is a Contract Negotiator for the Federal Systems Division of IBM.

The early success of Frank Shull, U. of Maryland, '58 — some observations

Following his first full year of life insurance selling, Frank Shull was named "Most Valuable Associate" of his agency. And not the least of his accomplishments that year was the sale of nearly $800,000 of new life insurance.

To achieve success in a new career so rapidly is unusual — but less unusual in a New England Life sales career than in many others. There are good reasons. Tangible reasons, such as screening and training. Our candidates must, from the start, measure up to demanding standards. Then they participate in programs of study and practice at a General Agency, under the expert supervision of men who are themselves eminently successful. Finally, special schools at our home office hone their skills even further, building confidence along with competence.

But there are also intangible reasons for success — the variables in each of the candidates — ambition, motivation, character. The first may well determine his income, the second his attitude toward his profession, the third the manner in which he serves his clients. There can be no real success, early or otherwise, unless a man has all three attributes in the highest form.

If a career with New England Life sounds good to you, let us know. We'll see that you receive more information about the opportunities for men who meet our requirements. Write to Vice President John Barker, Jr., 501 Boylston Street, Boston 17, Mass.

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New England Mutual Life Insurance Company: Founder of mutual life insurance in America in 1835. All forms of individual and group life insurance, annuities and pensions, group health coverages.

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OUR EXCLUSIVE LIGHTWEIGHT SUITS
made on our own distinctive models

We have an unusually comprehensive and good-looking selection of cool, comfortable suits...all reflecting our standards of quality and taste...and all moderately priced. Included are:

Our New Orlon® Acrylic and Dacron® Polyester Town Wear Suits, $60

Distinctive Dacron® Polyester and Worsted Tropicals, from $80

Our Remarkable Brooksweave Suits,* $49.50

Lightweight Dacron® Polyester and Worsted Gabardines, from $95

Our Traditional Cotton Seersucker Suits, from $35

Wash-and-Wear Dacron® Polyester and Rayon Suits, $42.50

Our Washable Cord Suits, $35 *and* $39.50

*Dacron and cotton

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Individuals Noteworthy

(Continued from page 8)

New Posts

NAMED in the news recently were the Alumni whose elections, promotions, and appointments are reported below:

William C. Foster, '18, as President, the new United Nuclear Corporation . . . *Philip S. Brown, '20,* as Vice-president, Hartford Accident and Indemnity Company . . . *James F. Brittain, '22,* and *Alexander J. Bone, '24,* respectively, as President and as a Director, Boston Society of Civil Engineers . . . *Hartselle D. Kinsey, '24,* as Vice-president, Union Carbide Corporation;

Ralph F. Gow, '25, as a Director, Miniature Precision Bearings, Inc., Keene, N.H. . . . *Karl R. Van Tassel, '25,* as President, the A. B. Dick Company, Chicago . . . *Harold E. Edgerton, '27,* as a Director, Wyle Laboratories, El Segundo, Calif. . . . *William Arnott, Jr., '33,* as Chief Engineer, York Research Corporation, Stamford, Conn. . . . *John R. Wiley, '33,* as President, The Wings Club, New York;

Richard S. Robinson, '36, as Vice-president, Arthur D. Little, Inc., Cambridge, Mass. . . . *James D. McLean, '37,* as President, General Dynamics/Electronics Division of General Dynamics Corporation . . . *Charles J. Donlan, '38,* as Associate Director, Langley Research Center, National Aeronautics and Space Administration, Langley Field, Va. . . . *Forrest H. Judkins, '38,* as Manager of Manufacturing, Insulator Department, General Electric Company, Baltimore, Md. . . . *Herbert A. Finke, '39,* as Vice-president and General Manager, Bomac Laboratories, Inc., Beverly, Mass.;

Maurice A. Meyer, '39, as Vice-President, Adcole Corporation, Cambridge, Mass. . . . *Walter B. Brewer, Jr., '40,* and *William W. Drake, Jr., '51,* respectively, as Assistant General Manager, Engineering Division, and as Treasurer, Aerospace Corporation, El Segundo, Calif. . . . *William R. Stern, '40,* as Sales Manager, Itek Electro-Products Company, Cambridge, Mass.;

(Continued on page 48)

You Can Beat the Heat if You're in Any of the Very Comfortable

5 Haspel Refreshable Suits

3 MONTH PAY-PLAN

The Sophisticated Wash and Wear Clothing for Comfortable Summer Wear

The best way we know to keep cool wherever you go is to get a wardrobe of cool Haspel clothing. Haspel wash and wear suits require next to no care. Very little ironing, if any, is necessary.

The Sir Perior Cord
75% Dacron—25% Cotton
39.95

The Sir Perior Covert Tones
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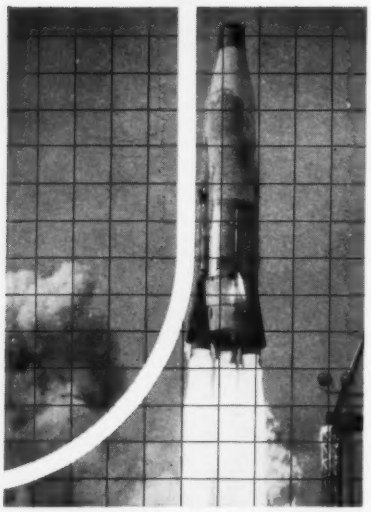
Haspel Dacron-Orlon
50% Dacron—50% Orlon
45.00

Haspel Creslan
50% Creslan—30% Dacron—20% Rayon
45.00

Poplin Suits
65% Dacron—35% Cotton
45.00

KEEP **THE COOP** *IN YOUR BUY-LIFE*

The first six years
of **S**pace **T**echnology **L**eadership



Since 1954, when the Air Force ballistic missile program was accorded top national priority, Space Technology Laboratories has been engaged in virtually every major phase of research, development, testing and technical management of missile and space systems. STL's contributions have hastened the day of operational capability for Air Force ballistic missiles, and have been applied as well in satellite projects and space probes.

Today, as STL's activities expand in significance and scope, STL offers exceptional opportunity to the outstanding scientist and engineer whose talents and training will add to, and benefit from, the accumulated experience that has enabled STL to conceive and accomplish major advances in the state-of-the-art. STL's creative flexibility, anticipating and responding to the demands of space progress, ranges in application from abstract analysis to complex hardware fabrication for military and civilian space projects.

STL invites scientists and engineers to consider career opportunities in both Southern California and Central Florida. Resumes and inquiries directed to Dr. R. C. Potter at either location will receive meticulous attention.

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a subsidiary of Thompson Ramo Wooldridge, Inc.

Individuals Noteworthy

(Continued from page 46)

Robert H. Stocker, Jr., '40, as Executive Manager, New England Fire Insurance Rating Association . . . *M. Spalding Toon, '40,* as President, Ohio Barge Line, Inc., Pittsburgh, Pa. . . . *Norman C. Michels, '41,* as Vice-president, Facility Planning and Appropriations, U.S. Steel Corporation . . . *Howard J. Samuels, '41,* as a Director, Rochester Telephone Corporation;

Ralph G. Mork, '42, as Manager, Engineering Laboratory, IBM Federal Systems Division's Command Control Center, Kingston, N.Y. . . . *A. Donald Moll, '43,* as Vice-president and Sales Manager, Minneapolis Electric Steel Castings Company . . . *Lewis A. Rupp, '43,* as Executive Vice-president, Ionics, Inc., Cambridge, Mass.;

John O. Atwood, '45, as Product Line Manager, Vat & Sulfur Dyestuffs, General Dyestuff Company Division of General Aniline & Film Corporation . . . *Rae T. LaPier, '47,* as Director, Administration, Planning and Control, Research and Development Department, Colgate-Palmolive Company . . . *Roger L. Sisson, '48,* as Manager, Program Analysis, Technical Staff, Computer Products Operations, Aeronutronic Division, Ford Motor Company;

Wm R. Bidermann, '50, as Chief Production Engineer, Whittaker Gyro Division, Telecomputing Corporation, Van Nuys, Calif. . . . *Herman C. Fischer, '50,* as Chief, Cement Activities Section, Johns-Manville Company, Manville, N.J. . . . *Norman Rudnick, '52,* as Director, Transducers and Materials Laboratory, Gulton Industries, Inc., Metuchen, N.J.;

Robert A. Sherman, '55, as Assistant Comptroller, Kodak Park Works, Eastman Kodak Company . . . *James S. Hetherington, '58,* as Engineering Manager, Vacuum Furnace Division, Richard D. Brew and Company, Inc., Concord, N.H.

Memorial Exhibit

CLEVELAND's Health Museum has dedicated an exhibit of "Why Our Nation Grows" to the memory of Howard Whipple Green, '16, a noted statistician and leader in health and welfare work.

(Continued on page 50)

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the friendly land

Let your spirit expand in this land of magic charm...

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Proposed method of travel _____

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PASEO DE LA REFORMA 35, MEXICO CITY

Moment of Truth . . .

Remember? The bluebooks were passed, the exam questions posted . . . then the panicky moment of blankness before facts gradually swam into focus. Final exams were the crucible of study and, in a real sense, forerunners of the many "moments of truth" for which each of us must prepare throughout life.

Preparation for decisive moments is man's strategy in facing his future. But this planning needn't always be a lonely, uncertain affair. The experience and understanding of a Connecticut Mutual Life man can greatly facilitate the wise safeguarding of your family . . . and provide for the needs that loom ahead. Use the counsel of this objective partner. Out of a wide variety of policies and payment methods, a CML man will prepare the plan best suited to secure your dreams. He's a helpful man to talk with.

Dividends* paid to policyholders for 115 years

Owned by its policyholders, CML provides high-quality life insurance at low cost and gives personal service through more than 300 offices in the United States.

**Dividend scale for 1961 increased 12½% over 1960.*

Connecticut Mutual Life
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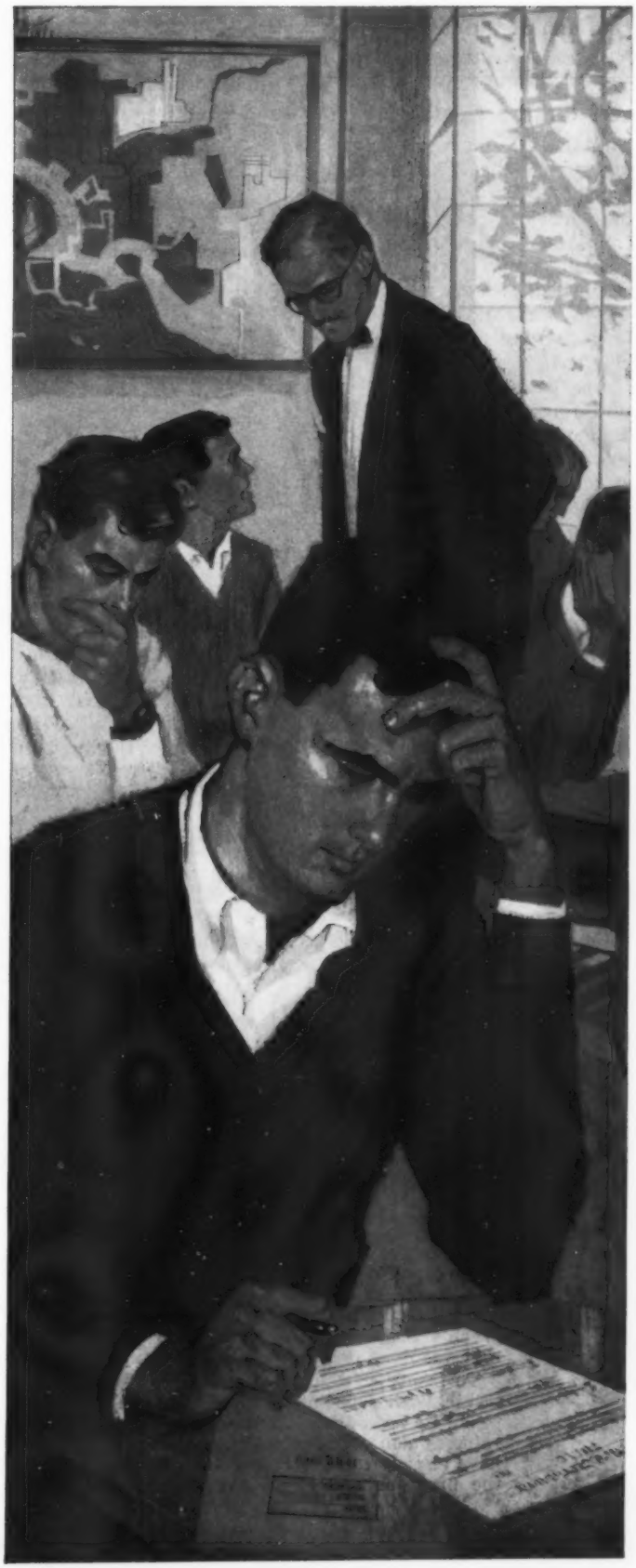

Individuals Noteworthy

(Continued from page 48)

Art for the Centennial

THE CENTENNIAL SHOW in the art gallery of the Charles Hayden Memorial Library featured paintings, drawings, prints, and sculpture from the collections of M.I.T. Alumni. Contemporary work predominated, and the oldest painting shown was Manet's *Self-Portrait,* done five years before M.I.T. was chartered.

The lenders included the widow of Edwin S. Webster, '88; Robert D. Patterson, '20; Julius A. Stratton, '23; Paul Tishman, '24; R. Kirk Askew, Jr., '25; Samuel Glaser, '25; B. Sumner Gruzen, '26; James R. Killian, Jr., '26; John J. Wilson, '29; Mrs. Ernest B. Dane, Jr., '30; Nathaniel Saltonstall, '32; Armand P. Bartos, '35; Constantin A. Pertzoff, '35; Max Wasserman, '35; Christine F. Magriel, '38; I. M. Pei, '40; Walter A. Netsch, Jr., '43; Arthur E. Vershbow, '43; Jeptha H. Wade, 3d, '45; James L. Phillips, '47; John R. Myer, '52; Alfred C. Holland, '53.

Honors to Alumni

MEDALISTS and recent recipients of other distinctions include:

Edward C. Keane, '22, and *John S. Bethel, Jr., '38,* respectively, the Desmond FitzGerald Medal, and the Sanitary Section Award, by the Boston Society of Civil Engineers . . . *Harry Wexler, '39,* a Career Service Award, by the National Civil Service League . . . *I. M. Pei, '40,* the 1961 Brunner Award, by the National Institute of Arts and Letters;

Captain Kenneth M. Tebo, U.S.N., '47, the Navy Commendation Medal . . . *Captain Richard J. Hayes, U.S.A.F., '54,* the American Rocket Society's Annual Award for 1960 for the best paper by a graduate student.

Faculty Notes

NEWLY ELECTED President of the Institute of the Aerospace Sciences is Professor *H. Guyford Stever* of M.I.T. . . . Newly named Dean of the Boston University Graduate School is *Richard S. Bear,* former Professor of Biophysics at M.I.T.

PAUL A. SAMUELSON, Professor of Economics at M.I.T., has served on a Task Force for the American Economic Association concerned with a fundamental overhaul of economics teaching in high schools. Economics is the first of the social sciences to undertake reforms in secondary school work such as have been launched in physics and mathematics.

Symbol of Quality... and Leadership

in gas and electric home appliances

Whirlpool Corporation has grown from a manufacturer of only home laundry equipment to the world's foremost manufacturer of a complete home appliance line... *both* gas and electric. This growth is the direct result of a vigorous effort to provide American households with the best and most meaningful advancements.

To insure continuity of such advancements, Whirlpool employs over 1,000 people in its research and engineering laboratories alone. Out of these laboratories have already come such developments as the first gas and electric refrigerators which prevent the formation of frost in the food compartments, the first remote control room air conditioners, a gas range surface unit so precisely controlled that you can fry an egg in a paper plate, and an automatic clothes dryer that measures the moisture in the clothes and tempers the heat accordingly.

In Whirlpool's six plants and administrative facilities nearly 14,000 employees are working to produce and distribute a full-line of home appliances that measure up to the highest standard of quality – that of the American homemaker.

WHIRLPOOL CORPORATION, St. Joseph, Michigan

In Navy Research Post

JOSEPH H. ENGEL has been appointed associate director of the Operations Evaluation Group, a part of the M.I.T. Division of Sponsored Research which has carried out operations research for the Office of the Chief of Naval Operations since 1945. He will assist Jacinto Steinhardt, Director, in coordinating the activities of the group's three divisions (the Operations Evaluation Division and the Naval Warfare Analysis Division in Washington, and the Applied Science Division in Cambridge).

Dr. Engel, a mathematician who studied at the College of the City of New York and the University of Wisconsin, won the Distinguished Flying Cross for flying 30 missions in B-29's.

Encyclopaedia Writers

M.I.T. IS represented among the new contributors to the 1961 edition of the Encyclopaedia Britannica by Professors *Robin Boyd, Carl T. Devine, Harold E. Edgerton,* '27, *Carle R. Hayward,* '04, *Andrew B. Jack, Rene H. Miller, Wayne B. Nottingham,* and *Walter Wrigley,* '34; Dean *George R. Harrison,* and Dr. *Harriet L. Hardy* of the Occupational Medical Service.

DAVID LATHAM, '61, won the New England wrestling championship in the 130-pound weight class in this year's tourney in the M.I.T. Armory. He is shown here accepting his wife's congratulations.

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Books

(Continued from page 28)

lic understanding of today's great engineering contributions to military and space technologies. Indeed, the word engineer appears only once, well towards the end of the book and only in an oblique way. Especially in the United States, where engineers have occupied a special position as instigators of social change, *Science and Government* is probably due for a round of polite but firm criticism on this score. At the very least, Sir Charles has slighted the great shift of American engineering emphasis, largely in the postwar period, towards systems concepts and a closer interlocking with science, both of which have had a pronounced effect upon the role of the engineer as a scientific adviser to government.

Sir Charles's historical observation that secrecy does not really impede scientific progress will also stir comment in the fundamental houses of American science. The science of which Sir Charles speaks throughout this book is, of course, not pure science at all but the large-scale systems developments which have been relatively well supported and which have indeed prospered behind locked doors because of forced draft. A great deal has been written on this subject already, and Sir Charles will doubtless rekindle some of the old fire.

A final comment about the great middle ground of political choices that lies between the life-and-death decisions in advanced societies: To C. P. Snow's brilliant observation about the need for more scientists to restore initiative in this whole area, one ought to add the need for a greater infusion of specialized knowledge of all kinds. This endless, workaday domain is where social and economic criteria are more widely practiced than at the life-and-death extremes of the political scale. Here there is urgent need for greater competence in all guises.

Technical Works

NEW PUBLICATIONS especially likely to interest Alumni of M.I.T. include:

Analysis and Design of Mechanisms, by Deane Lent, '42, Assistant Professor of Engineering Drawing at M.I.T. (Prentice-Hall, Inc., $3.25).

Computation of the Potential, Charge Density and Free Energy of the Electrical Double Layer Around a Spherical Colloid Particle, by Arthur L. Loeb, Associate Professor of Electrical Engineering at M.I.T., and others (The M.I.T. Press, $10).

Missile Configuration Design, by S. S. Chin, '46, Chief Aerodynamics Engineer, The Martin Company (McGraw-Hill Book Company, $11).

Modern Flight Dynamics, by W. Richard Kolk, '51, with a foreword by Shatswell Ober, '16, Professor of Aeronautical Engineering, Emeritus, at M.I.T. (Prentice-Hall, Inc., $7.50).

Science in Space, edited by L. V. Berkner and Hugh Odishaw, with contributions from Professor Bruno Rossi of M.I.T. and others (McGraw-Hill Book Company, $7.).

The Teaching of Elementary Economics, edited by Kenyon Knopf and James Stauss, with contributions by Robert L. Bishop, Professor of Economics at M.I.T., and others (Holt, Rinehart and Winston, Inc., $3.50).

(Concluded on page 54)

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Books

(Concluded from page 52)

THE TALE OF A POND, by Henry B. Kane, '24; Alfred A. Knopf ($3.00). *Reviewed by Richard H. Pough, '26, President, the Natural Area Council, the Association for the Protection of the Adirondacks, and the John Burroughs Association.*

IT HAS been said that "a scientist is born every time a youth is first fired with curiosity concerning the wonders of the world about him." It is equally important if he is to be channeled into science that his curiosity be encouraged and opportunities provided for him to read the book of nature.

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The Tale of a Pond is thus far more than just a beautifully written and illustrated book about the teeming life of a typical pond. As it tells what one boy found in his pond around the seasons and how he collected and studied its inhabitants, it suggests to the reader things it would be fun to do in his own neighborhood pond.

Everyone with children or grandchildren should see that they get this book the next time a present is called for. They should also see that the recipient is given help in setting up a few aquaria in which such pond dwellers as can be collected may be studied at close hand.

A Supplement to 'Technique'

THE M.I.T. YEARBOOK, *Technique*, has a 32-page supplement this year reviewing "A Century of Technology," in pictures that will interest many Alumni.

Included are views of the Mercantile Library on Summer Street where the first classes met, the Boston Back Bay district before and after the Institute was located there, the construction of the present main buildings in Cambridge, and the crossing of the Charles. The Class of 1873, the first student lunch room, the 1916 All-Tech Banquet in Symphony Hall, and many wartime and athletic events are also pictured.

The Editor-in-Chief was William R. Watson, '61; the centennial editor, John S. Maslanka, '61, and the layout editor, H. Reed Gregg, '63.

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COMMUNICATION FEEDBACK TECHNIQUES

Various system concepts being examined as promising alternatives to redundant coding for error correction in digital communications links. Both repeat request and average improvement types of systems are being studied, including unsolved problems associated with fading and noise on the feedback channel.

MODULATION SYSTEMS FOR SATELLITE RELAY COMMUNICATIONS

Study of advanced signal modulation techniques for use in satellite relay communication systems. A special emphasis is being placed on techniques with reduced vulnerability to interference, and relation to various problems of synchronization and possible application for adaptive (communication feedback) techniques.

Indicative of the calibre of the laboratory studies in communication techniques and the opportunities for individual scientific research, the following is a list of some papers recently accepted for publication in the literature:

- *Distortions of Angle Modulated Signals in Misaligned Linear Filters*, accepted for publication in Transactions IRE, PGCS.
- *Frequency Differences Between Two Partially Correlated Noise Channels*, accepted for publication in Transactions IRE, PGIT.
- *Binary Error Rates in Fading* FDM-FM *Communications*, accepted for publication in Transactions IRE, PGCS.
- *Binary Error Rates in Fast Fading* FDM-FM, accepted for publication in Proceedings IRE (correspondence).
- *On the Approach of a Filtered Pulse Train to a Stationary Gaussian process*, accepted for publication in Transactions IRE, PGIT.
- *A Theory of Antenna performance in Scatter Type Reception*, accepted for publication in Transactions IRE, PGAP.
- *Some Results in the Problem of Discriminating between Two Gaussian Processes*, accepted for publication in Transactions IRE, PGIT.

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